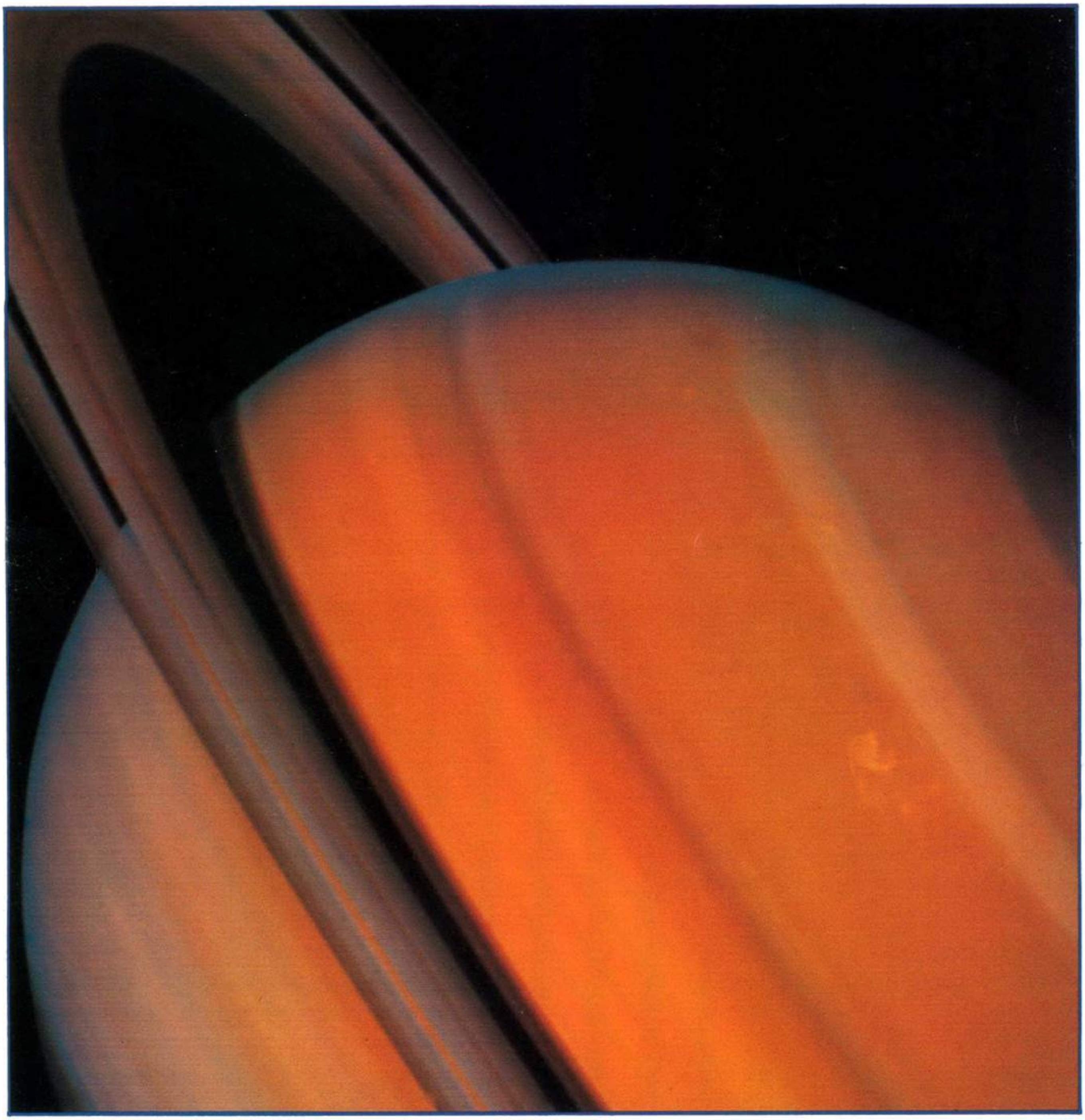
ASTRONOMY

November 1981
$2
UK 95p

Our Closest Look at Saturn

Searching for the First Galaxies
Reports on the Solar Eclipse



One Week before Encounter: Voyager 2

Meade System 2000

Think of the dimensions a truly research-quality instrument would add to your observing program.

Then consider moving up to the quality and performance of a Meade 4-inch or 8-inch Schmidt-Cassegrain. For Meade Schmidt-Cassegrains, both optically and mechanically, really are the finest instruments of their kind ever offered the serious observer and astrophotographer.

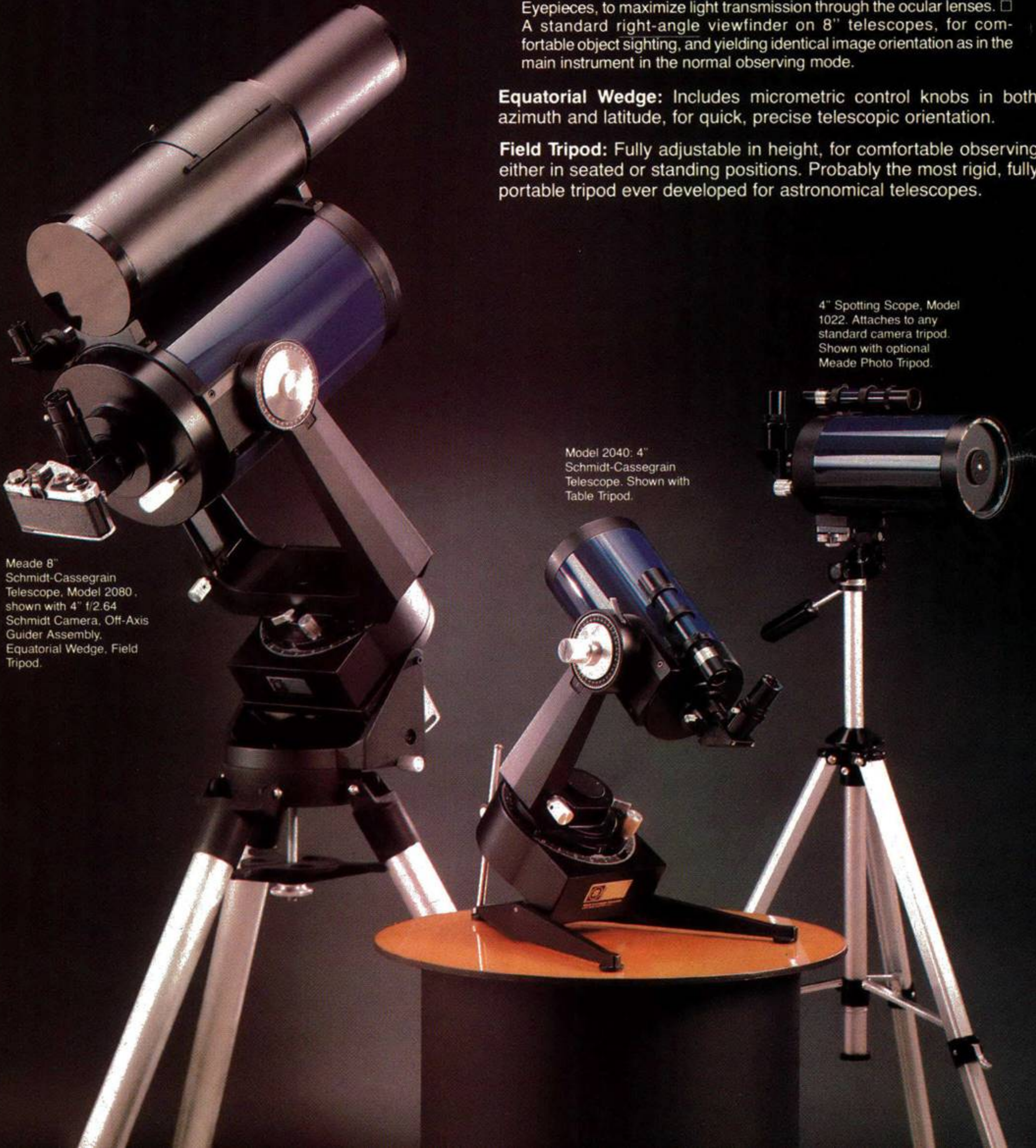
And, as parts of a wide-ranging system, they are instruments that will grow with your expanding horizons.

Standard Equipment: No other commercially available Schmidt-Cassegrains offer such a list of important technical advantages, much less as standard equipment included in the Base Price:

Worm gear drive systems, on both 4" and 8" models, for extremely low photo-visual periodic error and zero backlash. ☐ Ball bearings on both Declination and Polar Axes, permitting microsmooth tracking and precise balancing, even with the addition of auxiliary systems on the main telescope. ☐ On 8" models, an oversize 8.25" primary mirror, for a wider fully illuminated field, and to reduce the "edge darkening" of Schmidt-Cassegrains which use standard 8" diameter primaries. ☐ Multi-Coated Eyepieces, to maximize light transmission through the ocular lenses. ☐ A standard right-angle viewfinder on 8" telescopes, for comfortable object sighting, and yielding identical image orientation as in the main instrument in the normal observing mode.

Equatorial Wedge: Includes micrometric control knobs in both azimuth and latitude, for quick, precise telescopic orientation.

Field Tripod: Fully adjustable in height, for comfortable observing either in seated or standing positions. Probably the most rigid, fully portable tripod ever developed for astronomical telescopes.



4" Spotting Scope, Model 1022. Attaches to any standard camera tripod. Shown with optional Meade Photo Tripod.

Model 2040: 4" Schmidt-Cassegrain Telescope. Shown with Table Tripod.

Meade 8" Schmidt-Cassegrain Telescope, Model 2080, shown with 4" f/2.64 Schmidt Camera, Off-Axis Guider Assembly, Equatorial Wedge, Field Tripod.

Schmidt-Cassegrains

The System: Perhaps most importantly of all, Meade System 2000 Schmidt-Cassegrains are part of a wide and versatile system: the amazing 4" f/2.64 Schmidt Camera; 4" Schmidt-Cassegrain Photo-Guide Telescope with Illuminated Reticle Eyepiece; Dual-Axis Drive Corrector, and more — all of which attach easily and directly to 8" models.

Aesthetic Design: In the beauty of their enameled deep-blue tube surfaces, in the fineness of their machine-tooled mechanical components, Meade System 2000 models are light years ahead of the competition. See the System 2000 for yourself, and no further explanation will be necessary.

Warranty: As with all Meade products, the System 2000 is fully covered by the Meade One-Year Limited Warranty. See the Meade catalog for full details on this no-risk protection of your investment.

PRICE LIST

Model 2040:	
4" Schmidt-Cassegrain Telescope with Fork Mount ...... Base Price	**$595**
Model 2080:	
8" Schmidt-Cassegrain Telescope with Fork Mount ...... Base Price	**865**
Equatorial Wedge 4"/8"	**60**
Field Tripod 4"/8"	**160**
Table Tripod 4"	**40**
Table Tripod 8"	**50**
Model 1020: 1000mm f/10 Telephoto Lens	**325**
Model 1022: 4" Spotting Scope	**395**
Meade Photo Tripod for Models 1020 or 1022	**50**
Model 2066: 4" f/2.64 Schmidt Camera	**435**

All prices include packing. Complete telescopes are packed in luggage-quality foam-lined carrying cases. All prices F.O.B. Costa Mesa, California. Calif. residents add 6% sales tax.

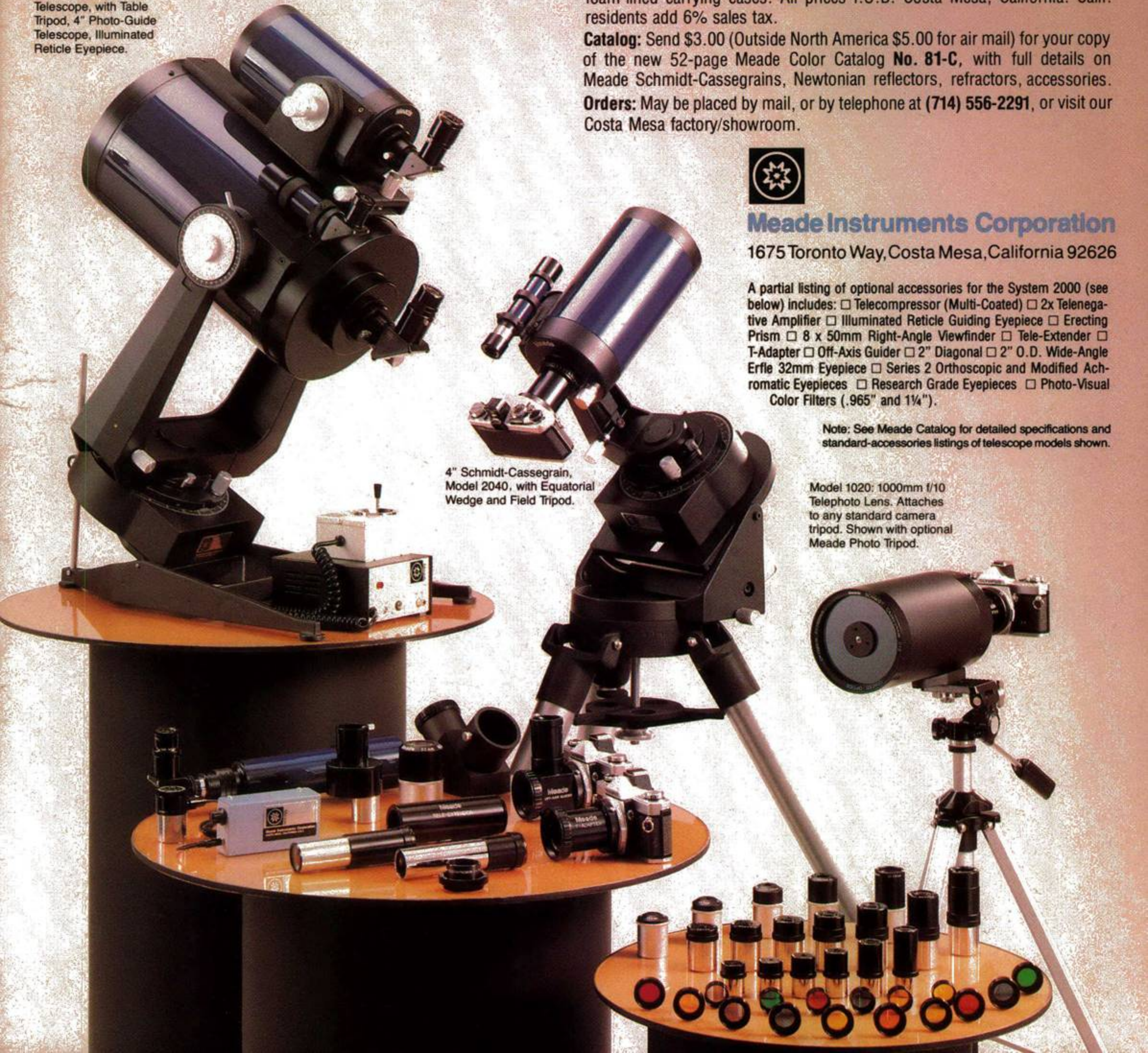
Catalog: Send $3.00 (Outside North America $5.00 for air mail) for your copy of the new 52-page Meade Color Catalog **No. 81-C**, with full details on Meade Schmidt-Cassegrains, Newtonian reflectors, refractors, accessories.

Orders: May be placed by mail, or by telephone at **(714) 556-2291**, or visit our Costa Mesa factory/showroom.

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, California 92626

A partial listing of optional accessories for the System 2000 (see below) includes: ☐ Telecompressor (Multi-Coated) ☐ 2x Telenegative Amplifier ☐ Illuminated Reticle Guiding Eyepiece ☐ Erecting Prism ☐ 8 x 50mm Right-Angle Viewfinder ☐ Tele-Extender ☐ T-Adapter ☐ Off-Axis Guider ☐ 2" Diagonal ☐ 2" O.D. Wide-Angle Erfle 32mm Eyepiece ☐ Series 2 Orthoscopic and Modified Achromatic Eyepieces ☐ Research Grade Eyepieces ☐ Photo-Visual Color Filters (.965" and 1¼").

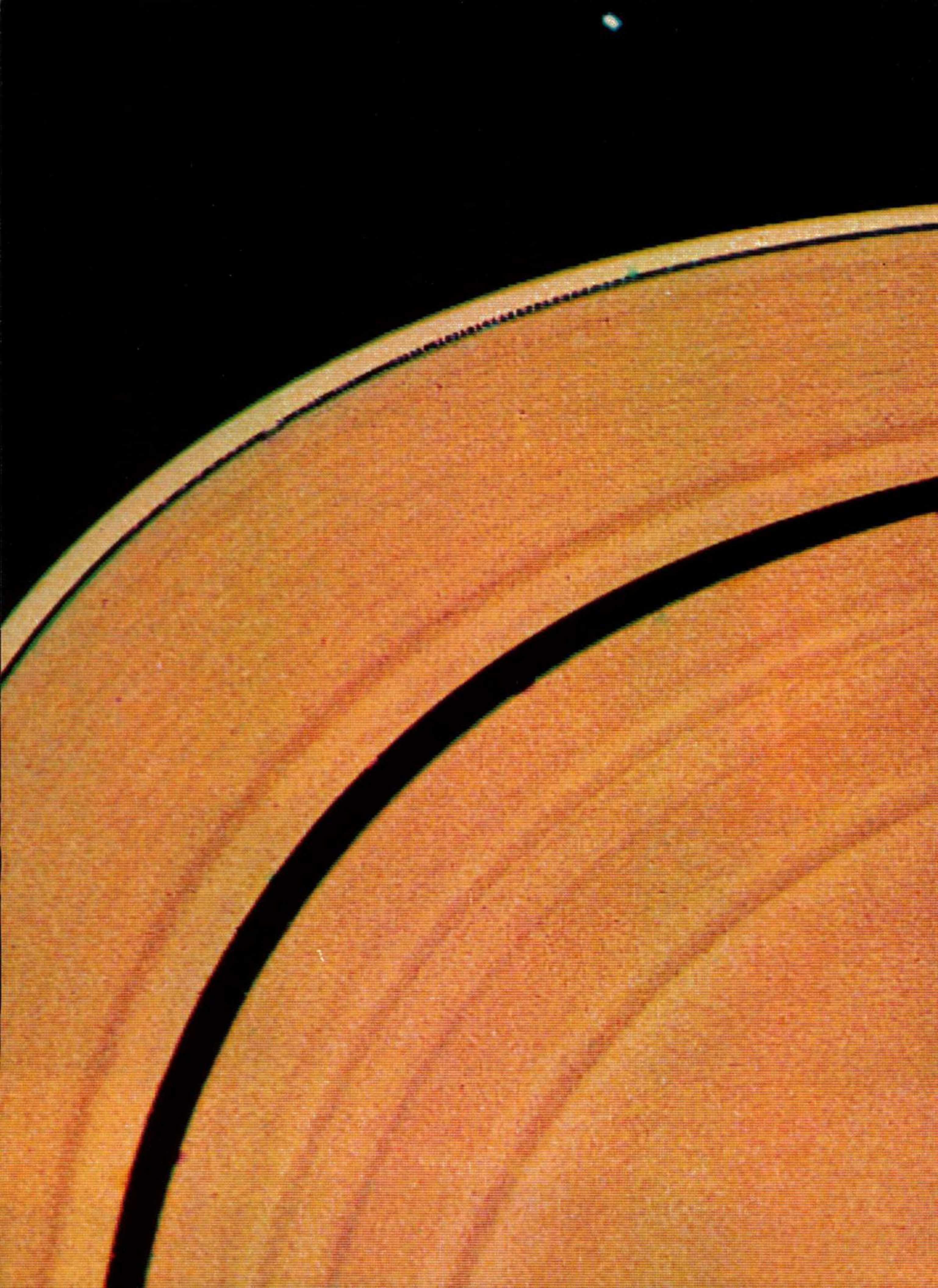
Note: See Meade Catalog for detailed specifications and standard-accessories listings of telescope models shown.



Model 2080: 8" Schmidt-Cassegrain Telescope, with Table Tripod, 4" Photo-Guide Telescope, Illuminated Reticle Eyepiece.

4" Schmidt-Cassegrain, Model 2040, with Equatorial Wedge and Field Tripod.

Model 1020: 1000mm f/10 Telephoto Lens. Attaches to any standard camera tripod. Shown with optional Meade Photo Tripod.



ASTRONOMY

Vol. 9, No. 11

November 1981

The World's Most Beautiful Astronomy Magazine • Established by Stephen A. Walther

Editor
Richard Berry
Managing Editor
Katherine King
Art Director
Thomas L. Hunt
Associate Editor
Robert Burnham
Assistant Editor
Betty Brunk
[illegible]
Ross Parker Simons
Art Assistants
Jane K. Borth
Mary MacAdam

President, AstroMedia Corp.
Robert A. Maas
Advertising Coordinator
Mary Kuklinski
Comptroller
Dennis K. Wilk
Product Manager
Susan Poole
Circulation Director
Kristie Roth
Circulation Manager
Rosemary L. Pickart

Film Production
Driscoll:Graphics Co.
Printer
W.A. Krueger Co.
U.S. Newsstand Distribution
Eastern News Distributors
111 Eighth Ave.
New York, NY 10011
Canadian Newsstand Dist.
Distr. Div. of TV GUIDE
112 Merton St.
Toronto, Ontario M4S 2Z7
World Newsstand Distribution
Boarts International, Inc.
1633 Broadway
New York, NY 10019

6 Voyager 2 at Saturn
by Richard Berry and Robert Burnham

Forum 32 Observing for Pleasure
Urban Astronomy
Interview with Dr. Hans Vehrenberg
Galaxies

In Focus 40

Behind the Scenes 41

Eye on the Sky 44 Planets Return as Nights Grow Longer
by Fred Schaaf

Gazer's Gazette 52 Observers' Reports on the July Eclipse

Photography in Astronomy 61 Cold Camera vs. Gas Hypering
by Bill Iburg

Equipment Atlas 66 Stellafane and the Art of Telescope Making

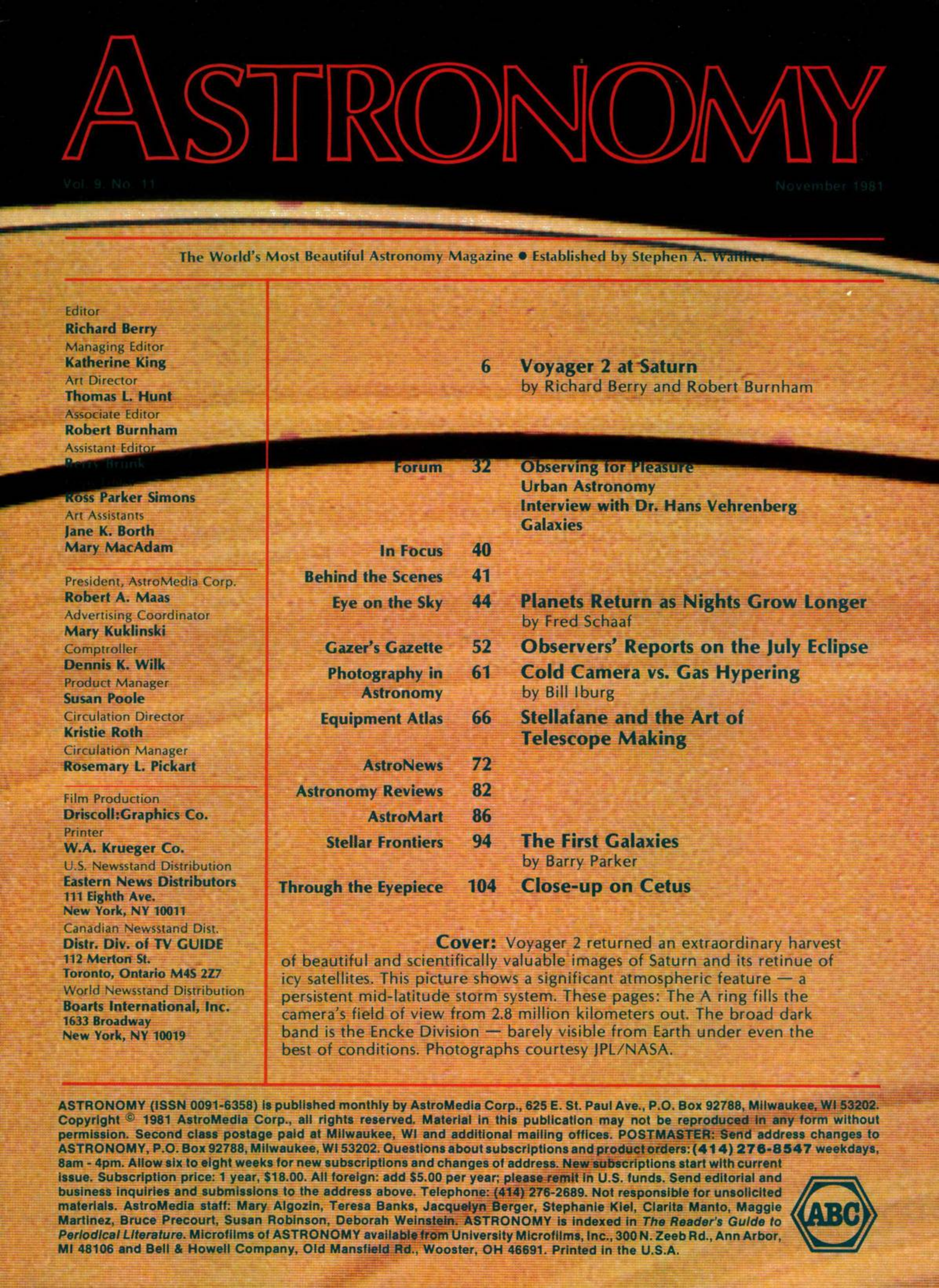
AstroNews 72

Astronomy Reviews 82

AstroMart 86

Stellar Frontiers 94 The First Galaxies
by Barry Parker

Through the Eyepiece 104 Close-up on Cetus



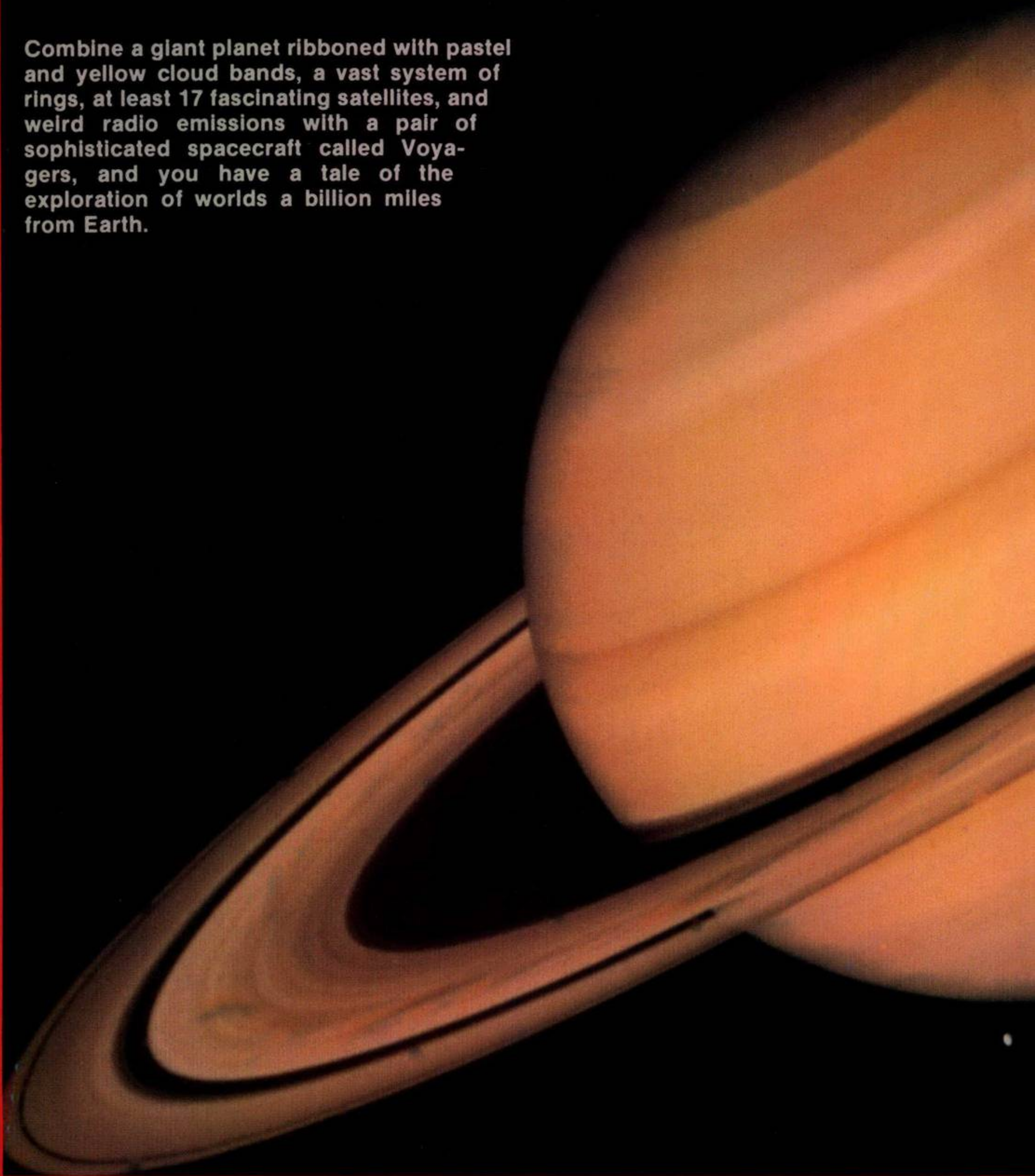
Cover: Voyager 2 returned an extraordinary harvest of beautiful and scientifically valuable images of Saturn and its retinue of icy satellites. This picture shows a significant atmospheric feature — a persistent mid-latitude storm system. These pages: The A ring fills the camera's field of view from 2.8 million kilometers out. The broad dark band is the Encke Division — barely visible from Earth under even the best of conditions. Photographs courtesy JPL/NASA.

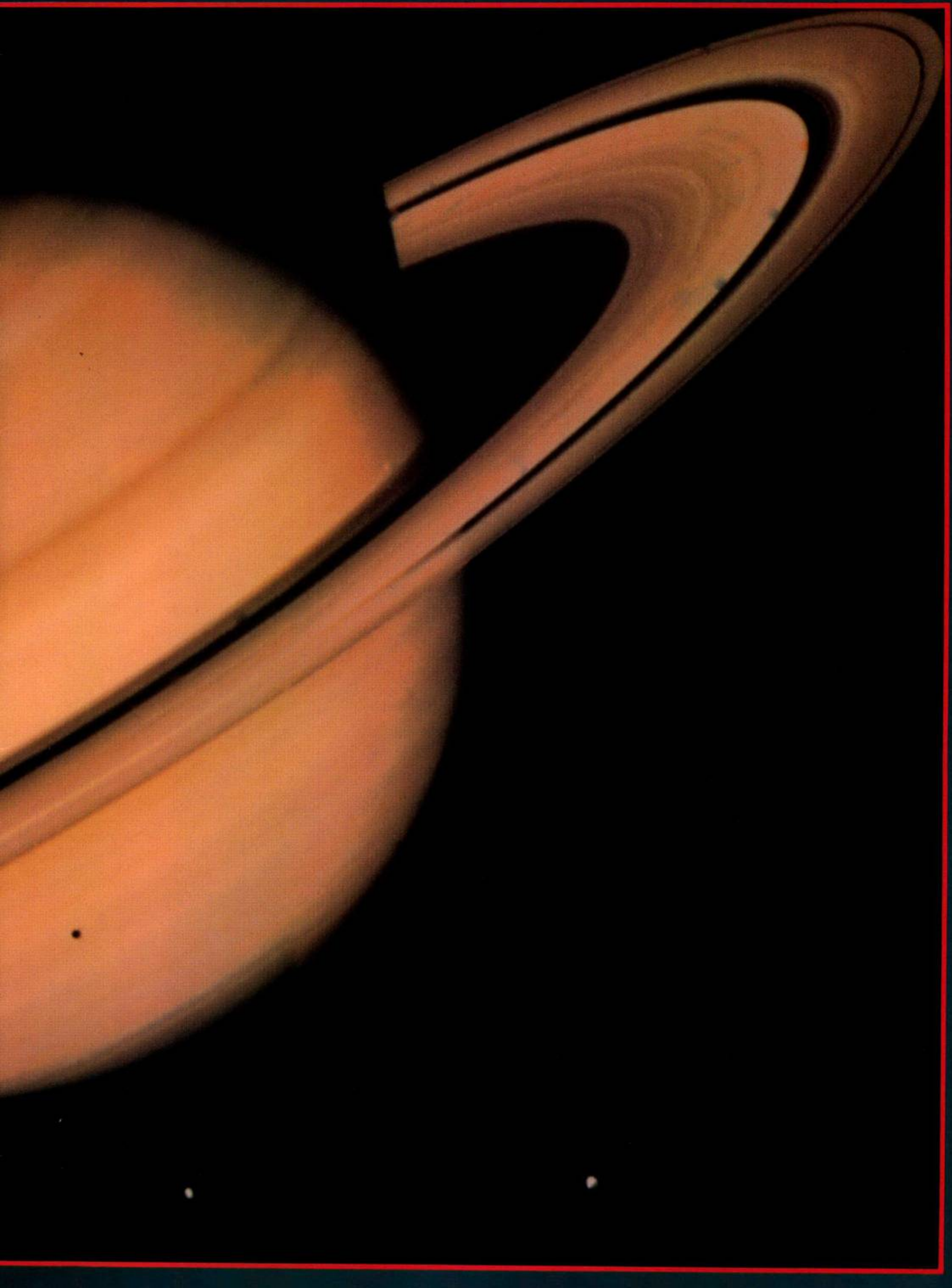
ASTRONOMY (ISSN 0091-6358) is published monthly by AstroMedia Corp., 625 E. St. Paul Ave., P.O. Box 92788, Milwaukee, WI 53202. Copyright © 1981 AstroMedia Corp., all rights reserved. Material in this publication may not be reproduced in any form without permission. Second class postage paid at Milwaukee, WI and additional mailing offices. POSTMASTER: Send address changes to ASTRONOMY, P.O. Box 92788, Milwaukee, WI 53202. Questions about subscriptions and product orders: (414) 276-8547 weekdays, 8am - 4pm. Allow six to eight weeks for new subscriptions and changes of address. New subscriptions start with current issue. Subscription price: 1 year, $18.00. All foreign: add $5.00 per year; please remit in U.S. funds. Send editorial and business inquiries and submissions to the address above. Telephone: (414) 276-2689. Not responsible for unsolicited materials. AstroMedia staff: Mary Algozin, Teresa Banks, Jacquelyn Berger, Stephanie Kiel, Clarita Manto, Maggie Martinez, Bruce Precourt, Susan Robinson, Deborah Weinstein. ASTRONOMY is indexed in *The Reader's Guide to Periodical Literature*. Microfilms of ASTRONOMY available from University Microfilms, Inc., 300 N. Zeeb Rd., Ann Arbor, MI 48106 and Bell & Howell Company, Old Mansfield Rd., Wooster, OH 46691. Printed in the U.S.A.

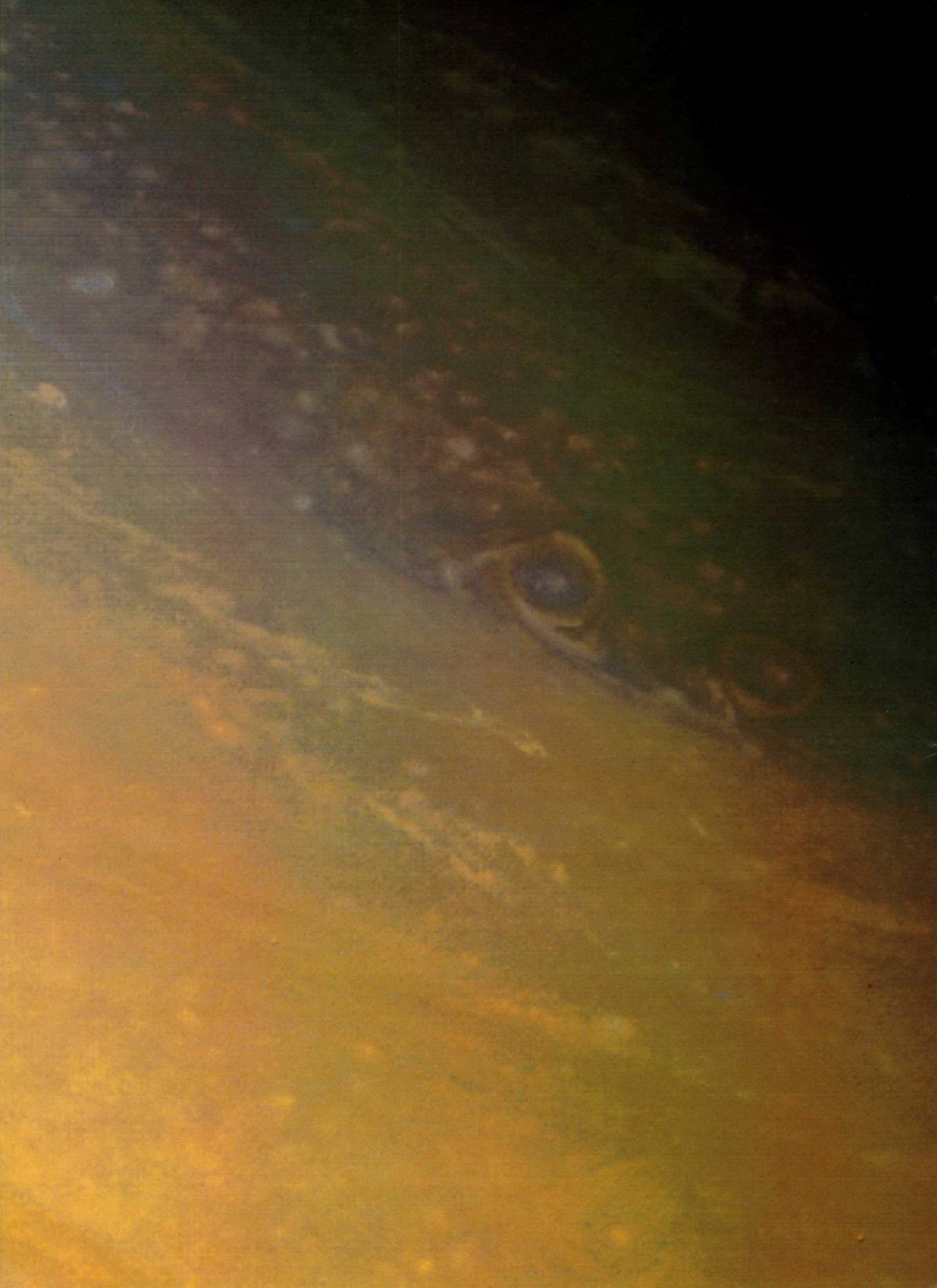
Voyager 2 at Saturn

by Richard Berry and Robert Burnham

Combine a giant planet ribboned with pastel and yellow cloud bands, a vast system of rings, at least 17 fascinating satellites, and weird radio emissions with a pair of sophisticated spacecraft called Voyagers, and you have a tale of the exploration of worlds a billion miles from Earth.







"I'm sure we missed discoveries the first time through . . . our feeling is one of anticipation"
— Ed Stone

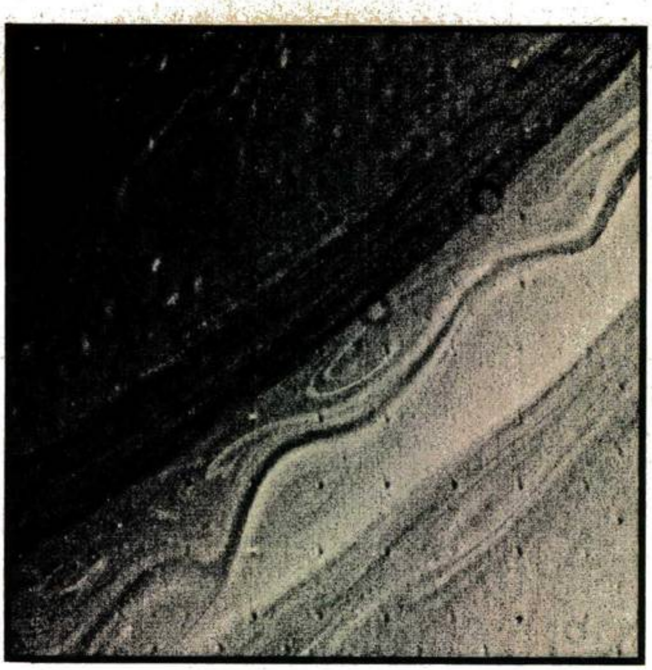
The heat of the day broke not long after sunset. Against the darkening horizon, a bright point of light appeared, at first barely visible. Then, as the sky turned from pink to blue to deep violet, a fainter point of light appeared above and to the left of the first. And then another, dimmer still, appeared above and to the right. None of the scientists working in the image processing laboratory saw them; only a few of the busy reporters in the hot and crowded press room stepped outside to watch three planets low in the evening sky. Virtually unseen, the triangle of planets — Venus, Jupiter, and Saturn — set in the west.

The action was inside, in front of video monitors displaying pictures radioed from a planet a billion miles away. As Voyager 2 accelerated toward that distant point of light, its cameras captured a panoply of cloud features, rings, moons and moonlets. Then it focused on still more tiny moons, more rings, more ringlets, and more surging cloudtops — in a tightly-planned imaging sequence determined months earlier. For the first time ever, humans saw the tantalizing details on the yin-yang satellite Iapetus, and the hamburger shape of Hyperion. Icy Enceladus became a world of plains, cracks, grooves, and deformed craters. Tethys displayed a crater the size of Mimas and a giant circumferential valley stretching three-fourths of the way around it. Pictures of the rings revealed puzzling structure finer than had ever been seen before. Humans saw the shapes and the battered surfaces of the F ring shepherd satellites; the co-orbitals, perhaps once a single satellite; the tiny Tethys Trojans; the single orbital companion of Dione; the surfaces of Dione, Mimas, and Rhea missed by Voyager 1; and took a second look, albeit a distant one, at Saturn's giant satellite Titan — truly a multiplicity of worlds.

On board the spacecraft, other sensors measured the magnetic and electrical fields in the space around Saturn, counted the impinging subatomic particles trapped in radiation belts around the planet, and recorded radio "sounds" bouncing about inside the magnetosphere. At 10:26 p.m. on August 25, the signal from Voyager stopped as the spacecraft plunged behind the limb of the planet, still taking pictures and recording data on its internal tape recorder.

Behind Saturn, Voyager passed through the ring plane a few thousand kilometers inside the G ring. Everyone waited nervously. How many other spacecraft had flown through the ring plane? Pioneer 11 had done it twice — safely. Voyager 1 had, but it had come in far out near Titan, and exited near Dione — protected from most impacts. Then, a few minutes after midnight, the big dish in Australia re-acquired the spacecraft signal. Champagne flowed, congratulations abounded, the "Goodbye Saturn" buttons were inverted to read "Hello Uranus."

But all was not well. Twenty minutes later, frames of Saturn's rings did not come back — only blank frames. Within minutes, spacecraft controllers knew they had a malfunction — the camera was not pointing at its intended targets. Their first reaction was to protect the cameras, so they sent signals to point the scan platform away from the Sun, which could have damaged delicate sensors. The platform responded, slewing toward safety in elevation, but not moving in azimuth. The cameras were pointed into space. They were safe, but not aimed at Saturn.



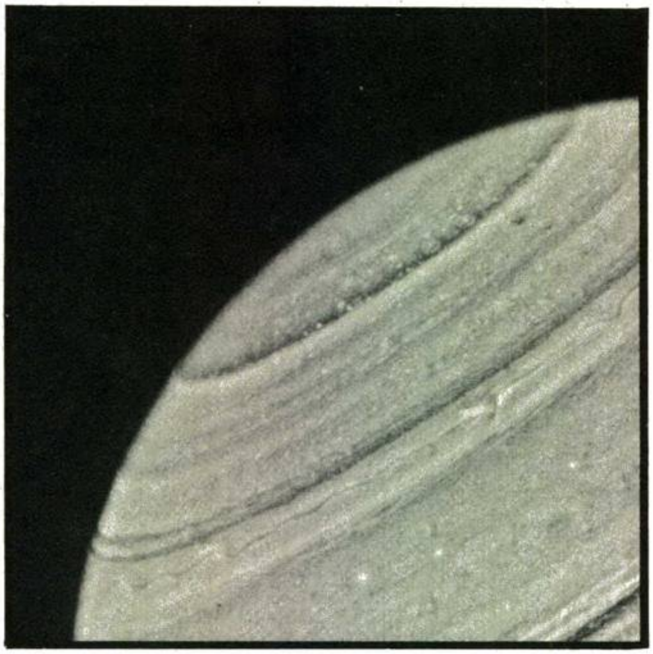
The next few days were extremely difficult for the spacecraft controllers. While always protecting the instruments on the platform, and thus the option to collect scientific data at Uranus and Neptune, they had to deduce what was causing the problem and correct it — if possible. It might be a program error, a computer failure, a problem in the electronics, a broken wire, or a mechanical setback like the jammed gears that had once hindered Voyager 1. No one knew.

To work out the problem, scientists devised a series of tests and gradually more ambitious platform maneuvers, until, less than three days after the problem had occurred, they had Saturn in the cameras again and the ultraviolet and infrared instruments began taking data on the backside of the planet. The diagnosis? Probably something mechanical — a bit of loose plastic stuck in the gears — the kind of problem that could be alleviated with continuing use. Full use of the platform might be restored after careful long-term testing and the platform once again trusted to point Voyager 2's cameras reliably, providing useful image science, infrared, ultraviolet, and photopolarimeter data at Uranus in four years, and Neptune in eight.

Voyager Mission Strategy

Project Voyager involved two spacecraft on a

Left: Two oval cloud systems (each 250 kilometers across) surround warm rising columns — about 60 kilometers across — and rotate counterclockwise as do similar storms on Earth. Many small, convective clouds are visible — appearing much like terrestrial cumulus — but they are made of ammonia ice and float in a hydrogen atmosphere. Above right: Vortices adjacent to a large-scale atmospheric wave (the wiggly ribbon of cloud) tell of an east-flowing jet stream in Saturn's northern hemisphere.



Above: The northern hemisphere shows clouds and bands extending well toward the pole. The dark wavy ribbon in the light band at 47° north latitude marks a 130 meter-per-second east-flowing jet (seen also on page 9). Right: South of the fast-moving wavy jet, a small bright disturbance has been coiled into a figure "6." South of this cloud (below), winds blow to the west at 20 meters per second.

Following pages: Two versions of the same images show a 3000-kilometer spot (blue or green in false color, but brown in reality) that moves west (left) at 15 meters per second while bright convective clouds move west 20 meters per second faster than the oval. The wavelike ribbon is a jet flowing at 150 meters per second to the east (right).

mission to explore Jupiter and Saturn. The first spacecraft, Voyager 1, was to fly through each system as if it were to be the only spacecraft to visit the system. Its investigations were the broadest possible: to survey everything, to get "first look" images at as much as it could — atmospheres, known satellites, rings, lightning, new satellites — whatever there was.

The second spacecraft, Voyager 2, was first and foremost a backup. If Voyager 1 failed, Voyager 2 would fly the reconnaissance mission. However, if the first mission was successful, the goal of the second spacecraft was to fly a complementary mission and see whatever Voyager 1 missed.

At Saturn, the primary goals of Voyager 1 were a close flyby of the planet, a close flyby of Titan, and a precise emergence from behind the equatorial zone for radio probes of the rings and the atmosphere. These goals were so important, particularly those concerning Titan, that the scientists willingly sacrificed a Voyager 1 mission to Uranus, Neptune, or Pluto to accomplish them. If Voyager 1 had failed, Voyager 2 would have been retargeted to include Titan in its flight plan, and, like Voyager 1, to exit the solar system with no further encounters.

As it turned out, the Voyager 1 flyby was virtually perfect. It returned first looks at Saturn, images from an intimately close flyby of Titan, a successful radio occultation of the rings, and closeup views of Mimas, Dione, and Rhea. Its survey of the ring system disclosed the B ring spokes, the braids in the three-stranded F ring, and unexpected fine structure in the rings. Voyager 2, released from the Titan flyby requirement, was targeted to Uranus, and programmed to fly a trajectory bringing it closer to the planet. This flight plan was better-placed relative to the rings, would send the craft through a new region of the magnetosphere, and included close approaches to Enceladus, Tethys, Hyperion, and Iapetus — a mission essentially complementary to the coverage of Voyager 1.

"We now have a very good estimate of the wind pattern in the northern hemisphere."
— Garry Hunt

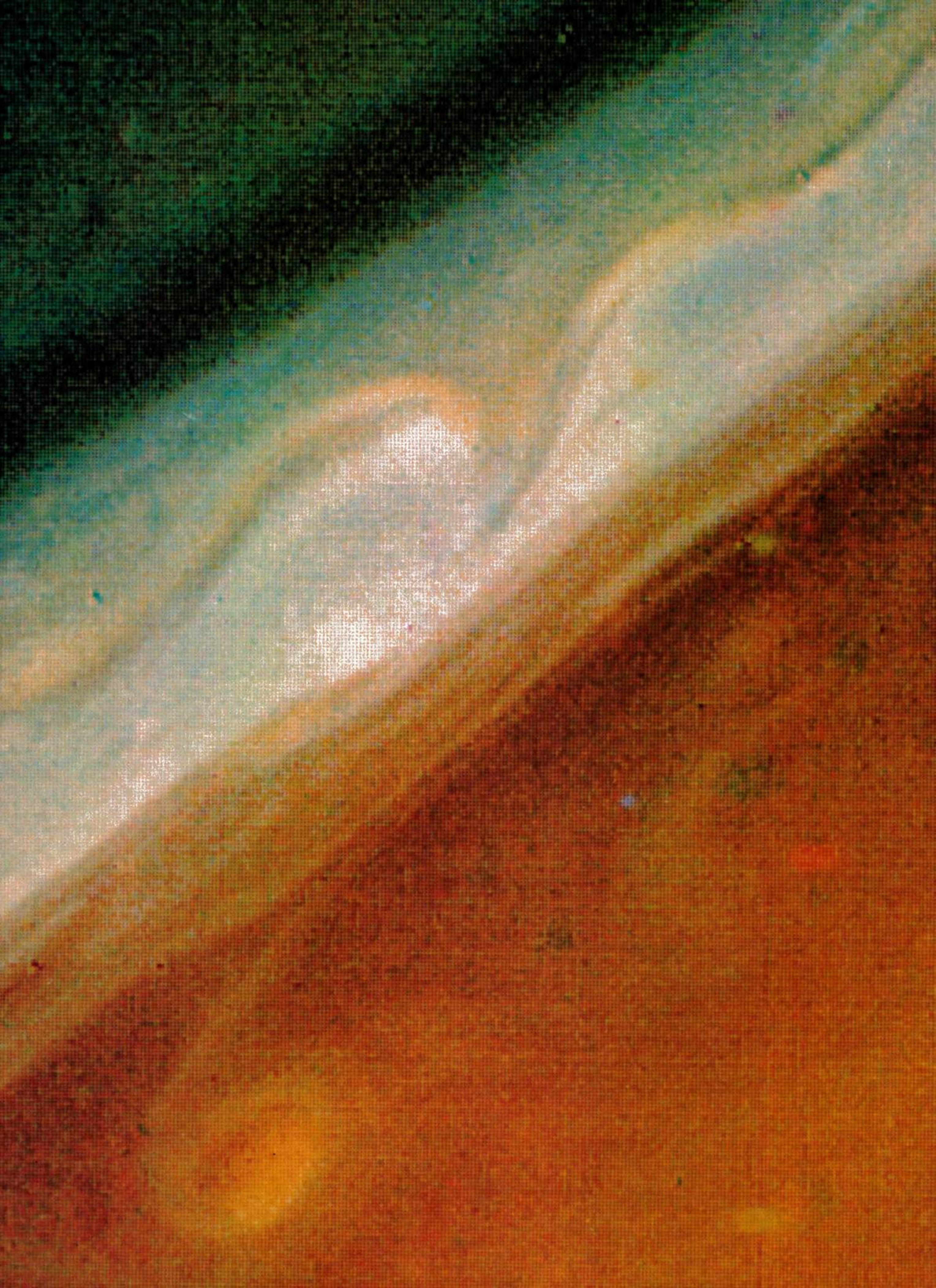
Furthermore, during the nine months between the missions, scientists re-thought their goals in the light of the Voyager 1 discoveries and changed the detailed sequence of image taking. Sacrificing any satellite imaging that repeated Voyager 1 coverage, they greatly increased and improved the coverage of the ring system — particularly of the B ring spokes and the F ring. They planned a search for tiny satellites embedded in the rings which might have explained the multitude of gaps. They also added special investigations of atmospheric storm systems. Then the pointing programs were written, checked, and held ready to "uplink" to the spacecraft. The Voyager 2 encounter with Saturn was about to begin.

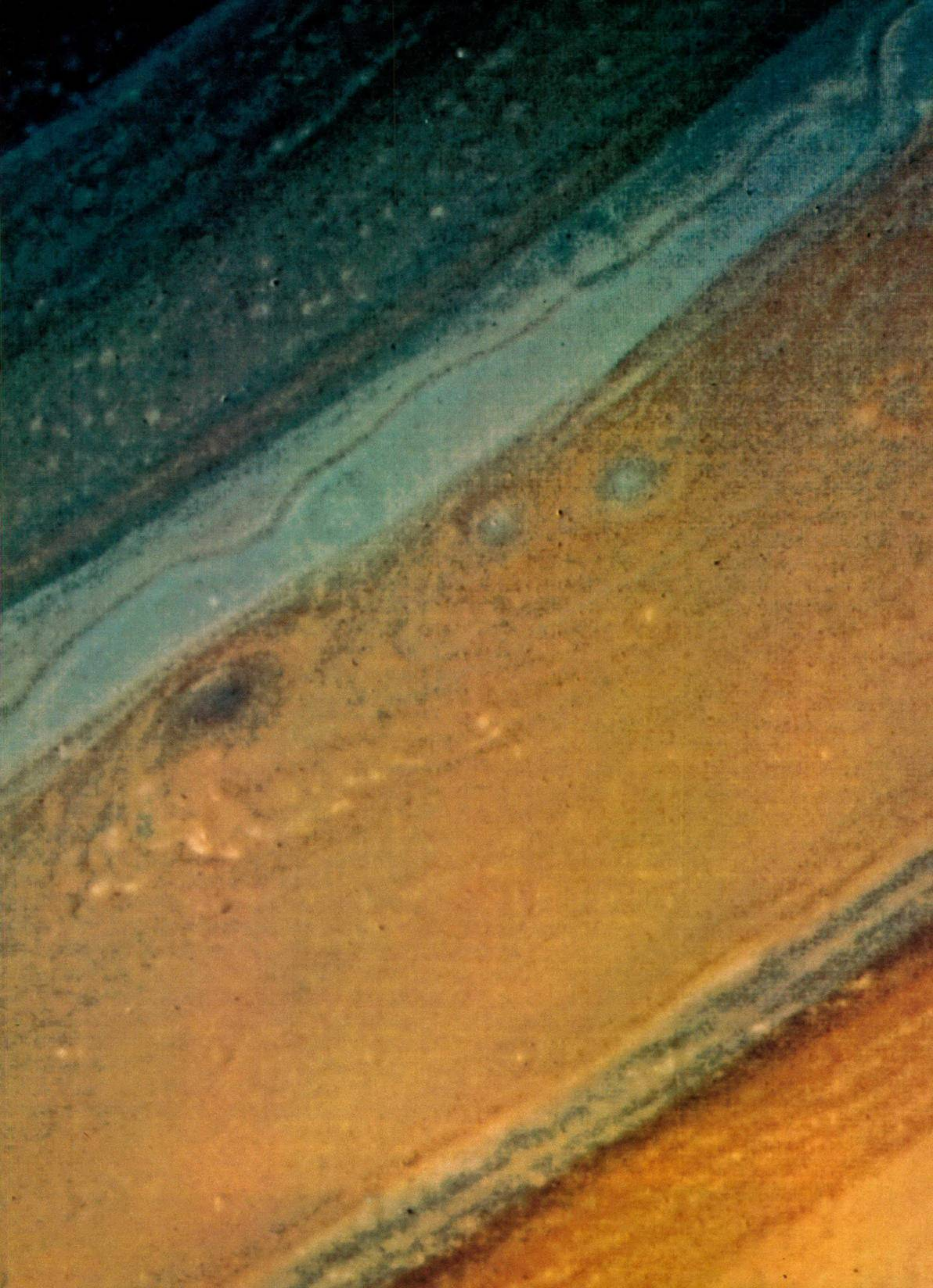
Saturn's Atmosphere

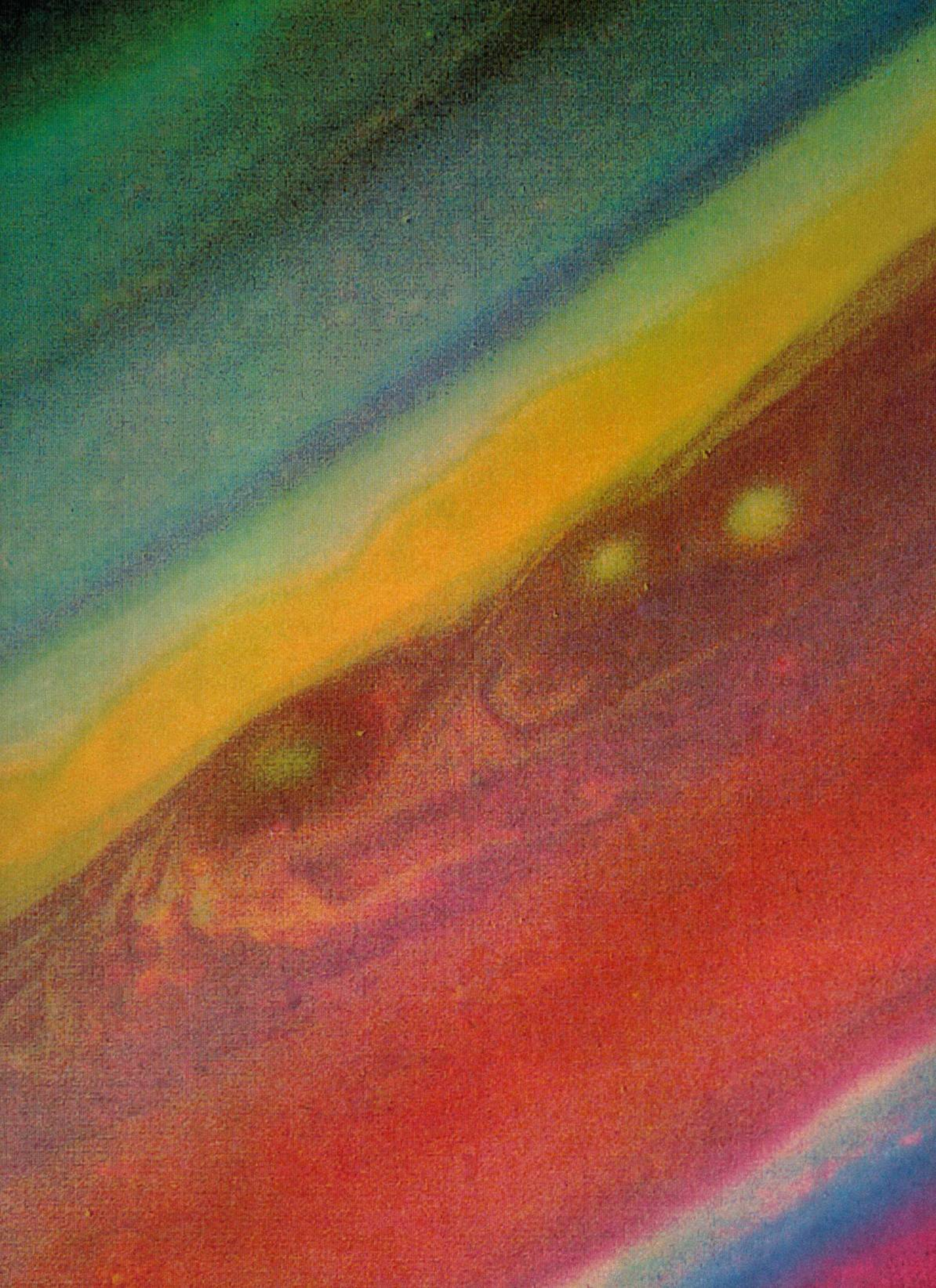
While Voyager 2 was still some 50 million kilometers from Saturn, it began to take long sequences of pictures for a thorough study of cloud patterns, or "weather." It didn't take long for the scientists to see that the pictures looked different this time: more clouds were forming, and the weather was more active than at the time of Voyager 1. The cloud patterns are important because they are the visible and traceable clues to the complex dynamics of a giant ball of rotating hydrogen.

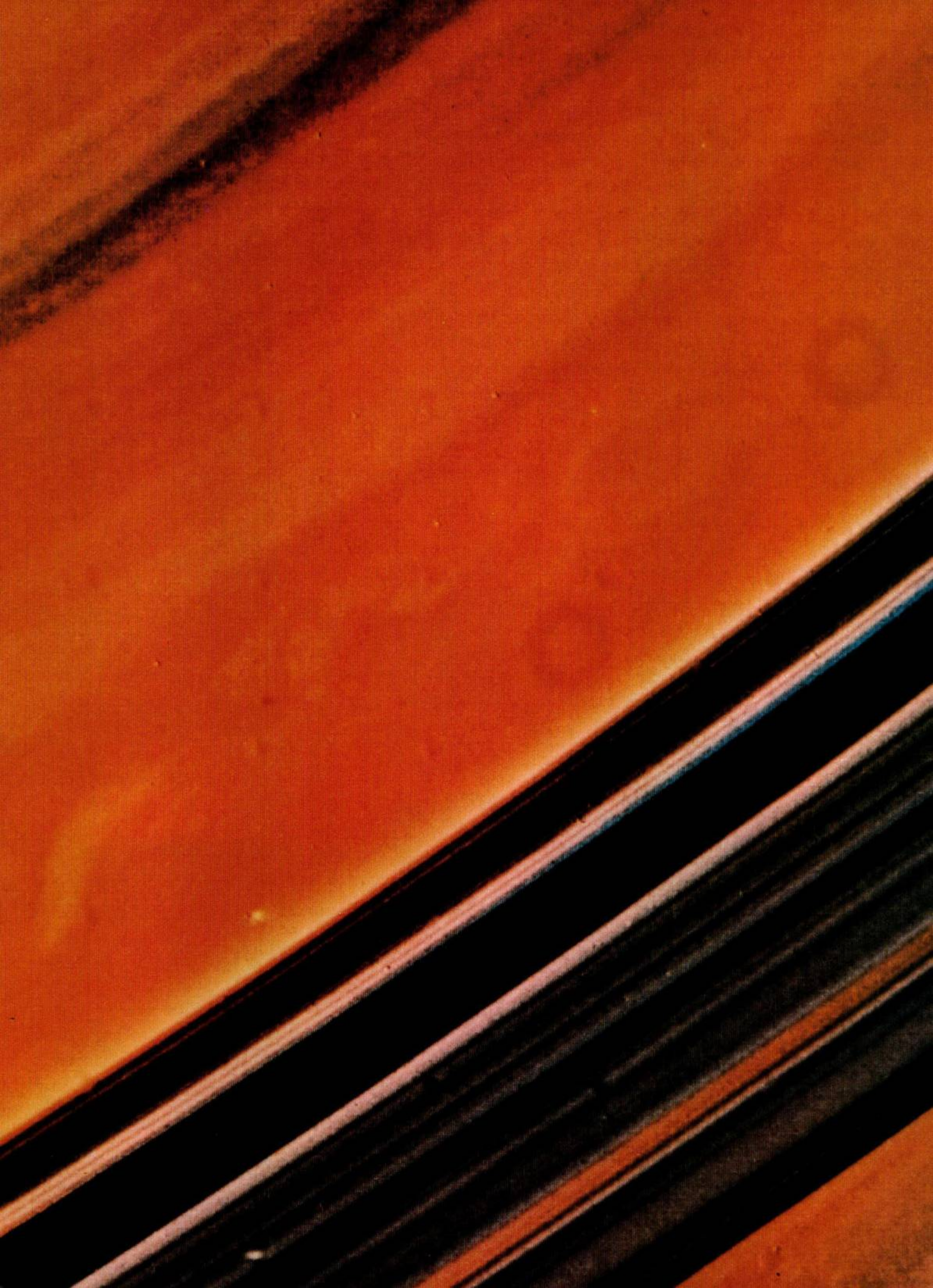
The clouds are impurities, representing about 1% of the bulk atmosphere — ammonia condensed into white droplets. The colors of the clouds are caused by even rarer impurities — just a few parts per million of carbon, sulfur, or phosphorus compounds — but vital as tracers for exploring the motions of the bulk material, hydrogen. What had happened? Several explanations were advanced: first, that the planet really *was* more active. When Voyager 1 flew past Saturn, it was almost exactly equator-on to the Sun, at the end of the saturnian northern hemisphere spring season. Nine months later the season had advanced, and the northern hemisphere was now inclined about 7° toward the Sun, moving toward the full heat of summer. Perhaps the basic circulation patterns had changed a bit, or perhaps the amounts of colorants in the clouds were greater.

Secondly, the Vidicon TV tubes in the cameras aboard Voyager 2 were more sensitive than those on Voyager 1. The larger signal gave more accurate, less noisy pictures which showed the low-contrast cloud features better. Perhaps, too, the high haze that plagued Voyager 1's view had abated somewhat. Or alternatively, the top of the cloud deck might be a little lower, and the temperature structure altered by









> **"With the rings, we now find ourselves at the point where we had hoped not to be. We've found no embedded satellites down to 10 kilometers diameter."**
>
> — Brad Smith

a few degrees so that clouds were more likely to form. Or maybe weather just never repeats itself, and Voyager 2 had arrived at a stormy time. Whatever the cause, there was more to see and the meteorologists were happy. They measured the motions and deduced wind velocities for dozens of small features, vortices spinning between the broad wind patterns, and bright plumes of warm material convecting from below.

One wind zone at 40° north latitude drew particular attention because many features formed, grew, and dissipated near its southern boundary. Embedded in the band of lightish clouds, a dark jet stream snaked around the planet. When a fluid flows too fast it becomes unstable and curls into a series of waves, as do the much gentler jet streams that flow around Earth. The troughs of the waves pull weather systems west to east across the United States and around the world. On Earth, a small planet, four to five waves go all the way around. On Saturn, there are many more.

More heat flows from the interior of Saturn than the Sun currently provides the planet — indicating that primordial heat is left over from its formation. Inside, masses of warm hydrogen, rising by convection, bring heat toward the surface. Where powerful winds exist, the convective pattern cannot be seen — but in zones where the winds are nearly still relative to the rotation of the core of the planet, and near the poles, meteorologists saw these convective plumes rising, spinning, spilling heat from the interior at the surface, then decaying and adding their kinetic energy to the jets.

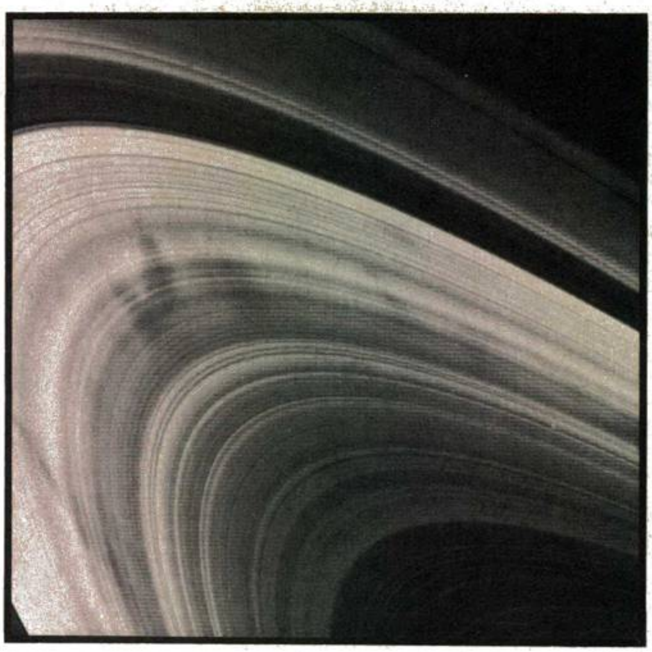
Unlike Jupiter, which has a large number of opposing winds, or jet streams — some blowing east and some west — Saturn has only a few opposing streams at high northern latitudes. Presumably they exist in the south also, though these have not yet been carefully studied. Saturn's atmospheric circulation is dominated by a powerful equatorial jet stream extending from 35°N to 35°S, and blowing eastward at 500 meters per second. Voyager 2 found the same general structure intact, and at high latitudes detected several of the same storms that Voyager 1 had seen, suggesting that they are, in fact, long-lived — just as Jupiter's "white oval" storm systems are. The saturnian ovals, generally brownish in color though one is ruddy, are vortices spinning between opposing flows; there are none at low latitudes on Saturn because the powerful equatorial jet blows only in one direction.

Thus, Saturn's blandness relative to Jupiter is partly because the basic pattern of atmospheric flow wipes out strong equatorial cloud features. But that doesn't account for all of it. From the Voyager images, astronomers proposed that because Saturn's atmosphere is cooler and the ammonia clouds form deeper in the atmosphere, the additional 50 or 100 kilometers of haze dulled the contrasts of a cloud deck as brilliant as Jupiter's. But careful examination of the Voyager photos showed that the haze is much thinner than orignally thought. Though still readily visible in images made in ultraviolet light, the haze isn't evident in orange or green light. Apparently, the underlying colors of the clouds are really less intense at Saturn than they are at Jupiter. The trace elements, the impurities that generate the color in Saturn's atmosphere, appear better mixed or less segregated on a planet-wide scale than those on Jupiter.

Magnetic Fields and Charged Particles

Extending hundreds of thousands of kilometers in all directions from Saturn are ghostly structures of magnetic fields, fast-moving atoms and ions, and subatomic particles collectively called the magnetosphere. It is primarily through its magnetosphere — with thousands of times greater volume than the planet itself — that Saturn interacts with the interplanetary medium. Voyager 2 was the third spacecraft to probe these vast but invisible structures. Its flight path took it through regions that had not been explored before — higher through the northern field and closer to the planet and the rings than Voyager 1.

Saturn's magnetic field, unlike that of Jupiter or the Earth, is almost perfectly aligned with the planet's rotational axis. Furthermore, it is a smooth and regular dipole field — like that of an enormous bar magnet — without lumps, bumps, or unusually strong or weak places. It is "inflated" slightly by an electrical ring current of three million amperes flowing through a plasma torus 8.5 Saturn radii from the planet. Overall, it is compressed on the Sun side and stretched toward deep space on the down-Sun side in a predictable way by the pressure of the solar wind.



Left: Saturn's equatorial regions display distinct features despite powerful winds that could destroy all cloud detail. The bright line is sunlight falling on the planet through the Cassini Division. Below the black shadow are the greyish rings themselves. The orange band is the planet shining through a gap in the rings. Above: "Spokes," the dark features on the B ring, were intensively studied by Voyager 2 cameras.

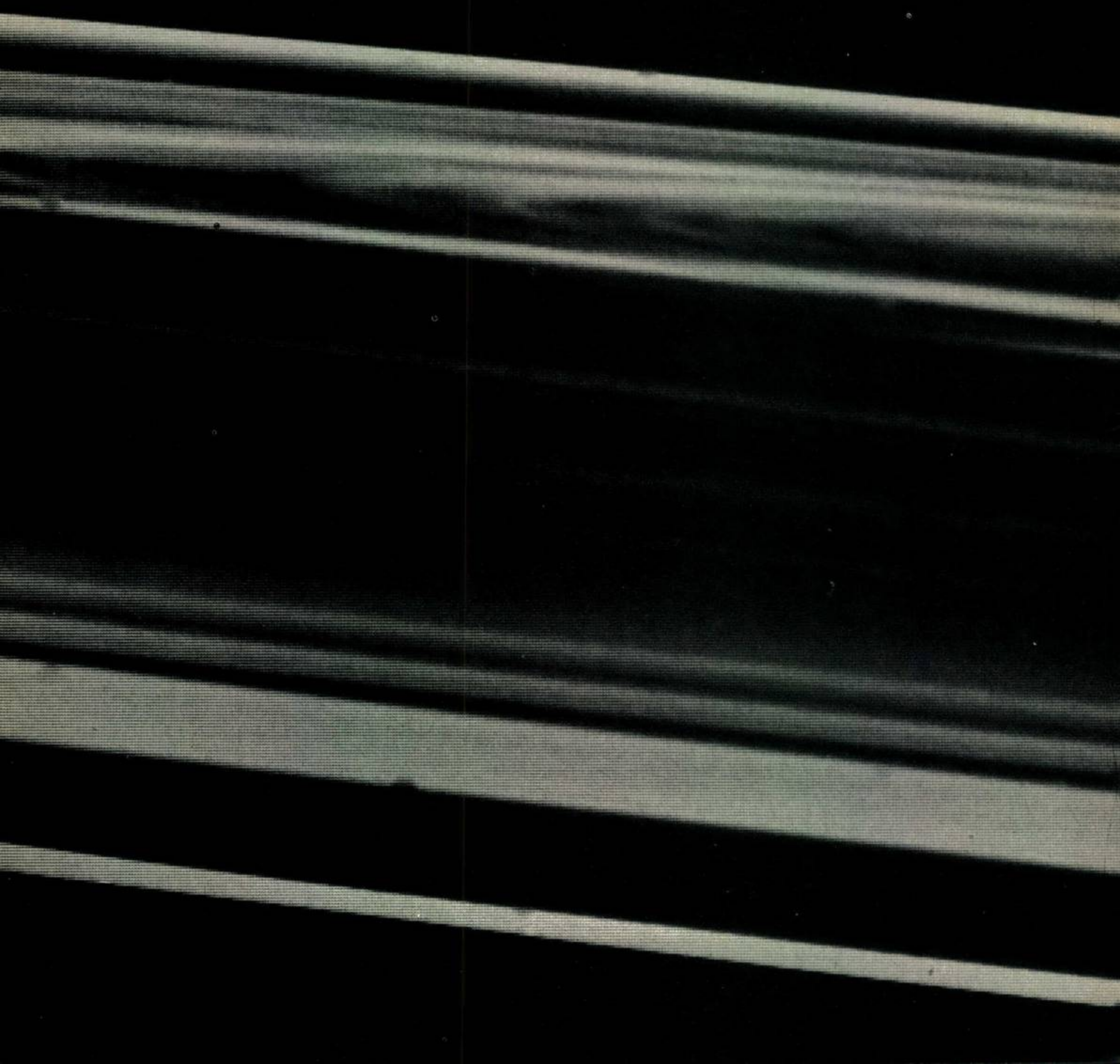
The field calculated from a simple mathematical model matches the field observed by Pioneer 11, Voyager 1, and Voyager 2.

But there is a quirk in this otherwise ordinary scenario: Saturn emits pulses of radio energy, at kilometer wavelengths, in a regular 10 hour 39 minute 26 second pattern. Voyager 1 and Voyager 2, in fact, picked them up months before encounter, confirming that the clock-like beat continued reliably. This pattern — somehow locked to the core of the planet through the magnetic field — defines the true rotation period of the planet far better than the wind-driven cloud patterns can.

However, a planet with a symmetric and smooth magnetic field should not produce modulated radio signals. Following Voyager 1's discovery of the kilometric radio emission, the scientists expected to find an anomalous region of some kind in the magnetic field. Although Voyager 2 carried out a careful search for such irregularities, it found none. The radiation comes from one longitude region on the planet, probably somewhere near the auroral zone, and turns on when that particular spot faces the Sun. It may be that the very small tilt of the saturnian field — a mere one degree — somehow triggers it.

To add still further complications, this radio energy appears to be modulated with a period of 66 hours, the orbital period of Dione. When Dione is in certain orbital positions, the kilometric radiation stops. There is a link, yet to be discovered, between the position of Dione and the saturnian kilometric radiation.

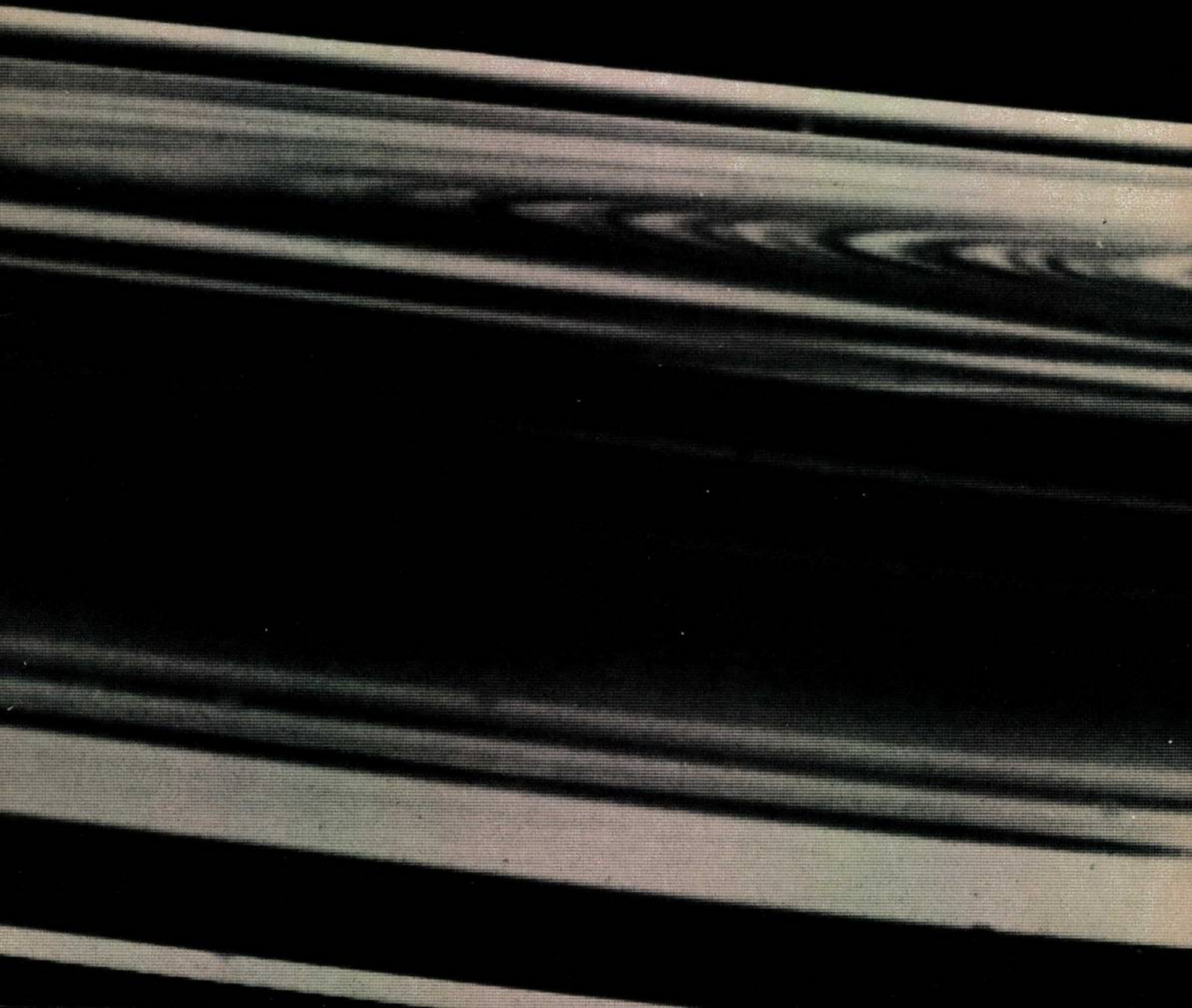
Because it has a magnetic field, Saturn has a magnetosphere. Plasma physicists think of a magnetosphere as a big bag of plasma and energetic particles trapped around a planet by its magnetic

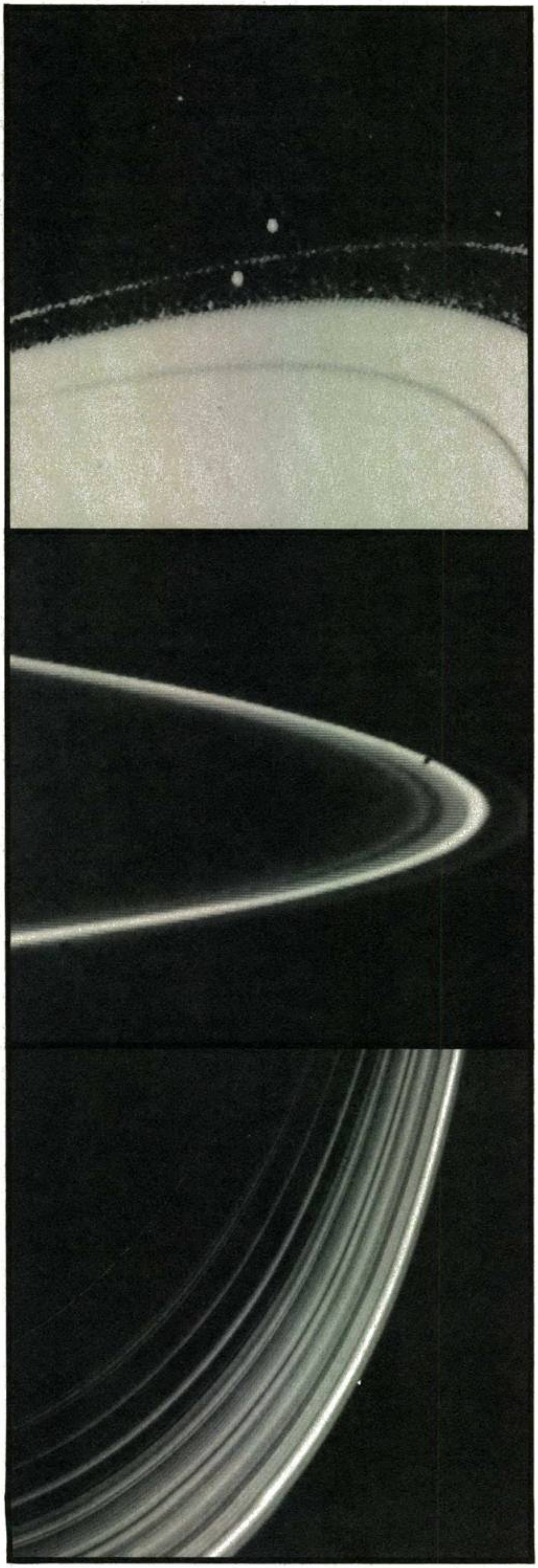


field. The particles are trapped because a charged particle cannot move across magnetic field lines without losing energy. It must move along them, often spiraling as it goes. Magnetic field lines emerge from one hemisphere of the planet, run perpendicular to the equator, then plunge into the other. Thus, charged particles cannot readily move inward or outward, but can easily move north to south and south to north. They are trapped. Bouncing back and forth along field lines between the hemispheres, these particles must ultimately funnel down the magnetic field and crash into the atmosphere around the poles — or hit something.

But what is there to hit? Both Voyager 1 and Voyager 2 sped through the regime of trapped particles and measured it. As the spacecraft crossed the orbit of each moon, sensors on board recorded a dip in the number of particles and radioed the numbers to Earth. The scientists were delighted: they detected even the smallest moons and thinnest rings by the bodies' particle absorption. And, because each moon punched a "hole" in the radiation belts, they could use the "holes" to follow the magnetic field lines with great precision. Based on the location of the

Minutes before it flashed through the ring plane, Voyager's wide-angle camera recorded this oblique view of the western side of the rings — with a bright spoke extending across the image. From top to bottom are the A ring, the Cassini Division (seen as a dark band), then the B ring with its end-on ringlets. At right is the C ring, identified by its bright and dark ringlets. The spoke appears as a bright straight band. About halfway down the image is the Cassini Division, then the A ring, the Encke Division, the bright outer edge of the A ring, the gap between the A ring and the F ring, and the F ring.





". . . intuition begins to fail you . . ."
— Lonny Lane

Tethys "hole," Voyager 2 particle scientists found roughly the same tilt of the magnetic field as the radio team needed to explain the pulsed radio emission.

Clearly, charged particles are intimately connected to Saturn's retinue of small satellites and the rings. Their icy surfaces may be the major source of a donut-like torus of heavy atoms measured by both Voyagers, as well as a sink for trapped high-energy charged particles. Tethys and Dione, in particular, lie at the zone of highest energetic particle flux. According to the Voyager measurements, they lose about 1 kilogram per second of their ices into a torus of heavy ions — elements heavier than hydrogen and helium — principally oxygen and carbon. The origin of the oxygen is easy — it's blasted from the ice surfaces of the satellites — but the source of the carbon is a mystery. It can't come from Titan because Titan would also supply nitrogen to the magnetosphere — and no nitrogen was detected. If the carbon does come from the satellites, then they still hide important secrets.

Another observation links the satellites to the magnetic fields and particles: audio frequency radio signals observed by both Voyagers that appear somehow associated with Tethys, Dione, and Rhea's orbits. Low energy electrons moving through the steep gradients around the "holes" in the plasma near the moon appear to be accelerated by the satellite, and radiate away energy at wavelengths of hundreds of kilometers — a true music of the spheres.

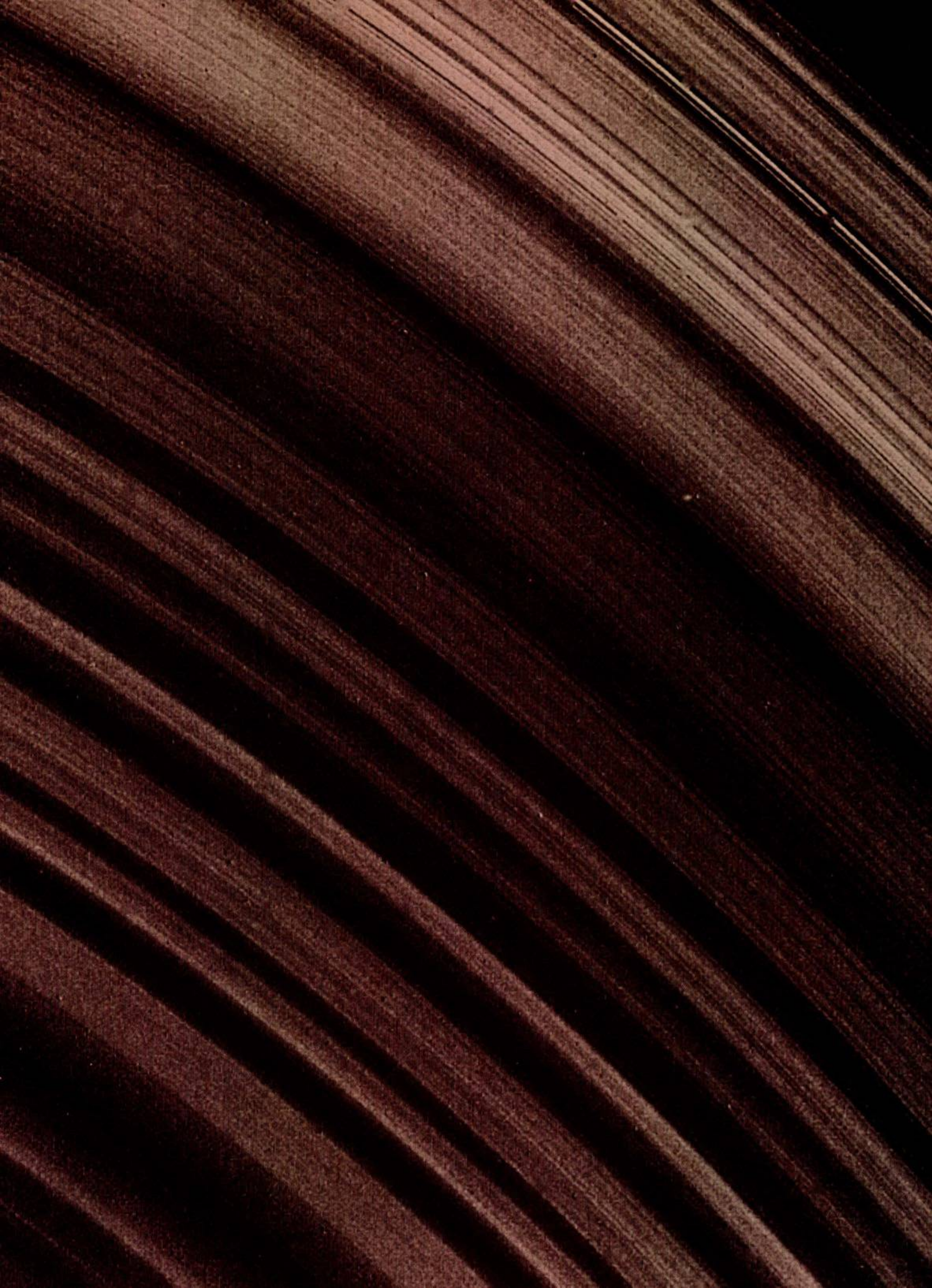
The Rings

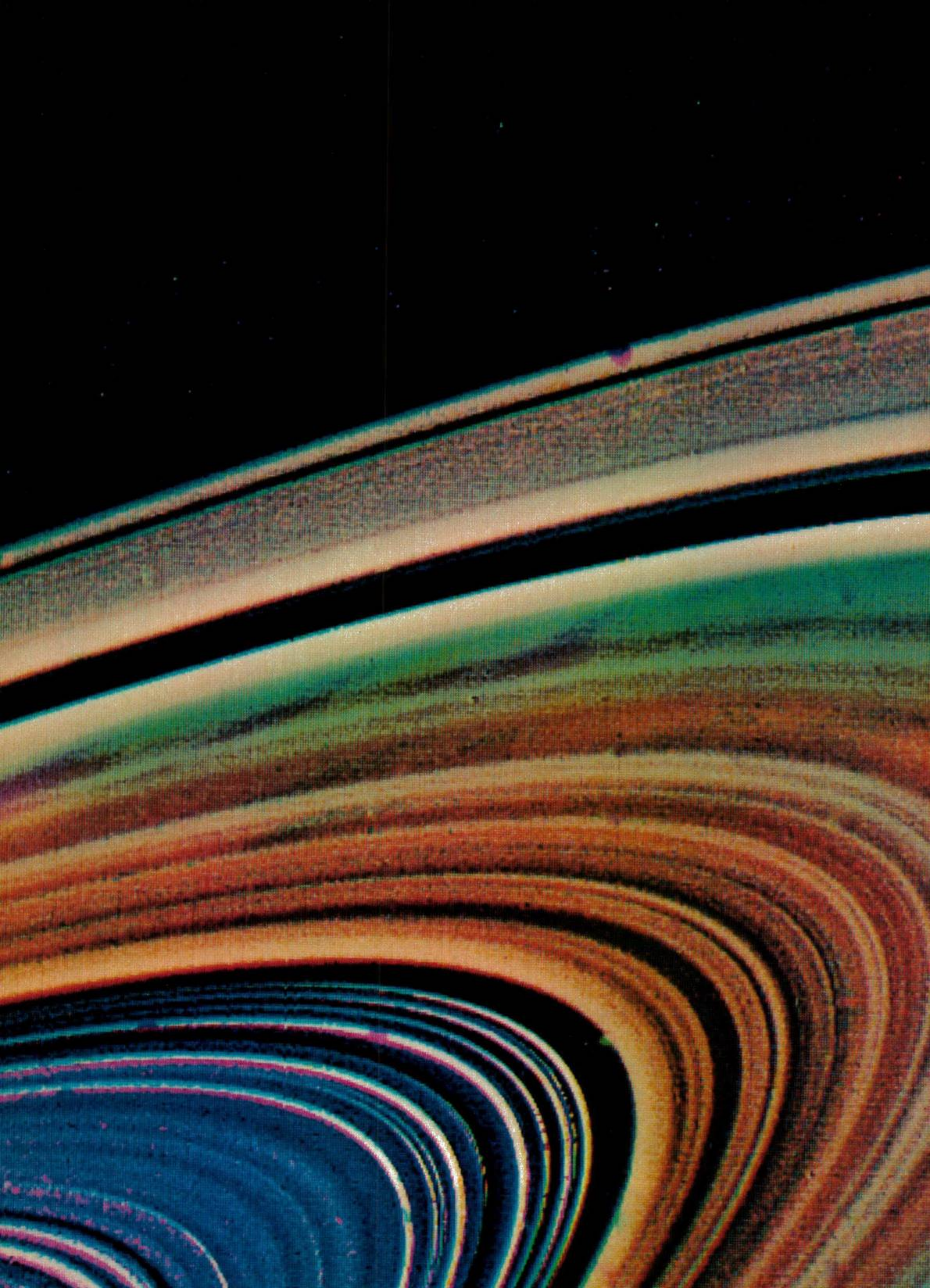
For hundreds of years astronomers counted only three rings around Saturn. Outermost was the A ring, 15,200 kilometers broad and containing a 200 kilometer dark gap, named the Encke Division after its discoverer. Separating the A ring from the B ring was a gap 3500 kilometers wide called the Cassini Division. The B ring — 23,500 kilometers across — was known to be the widest and brightest of all three. Adjoining its inward edge and extending down to 12,900 kilometers above Saturn's equatorial cloud-tops lay the dimmest ring, the tenuous and gauzy "crepe ring," or C ring.

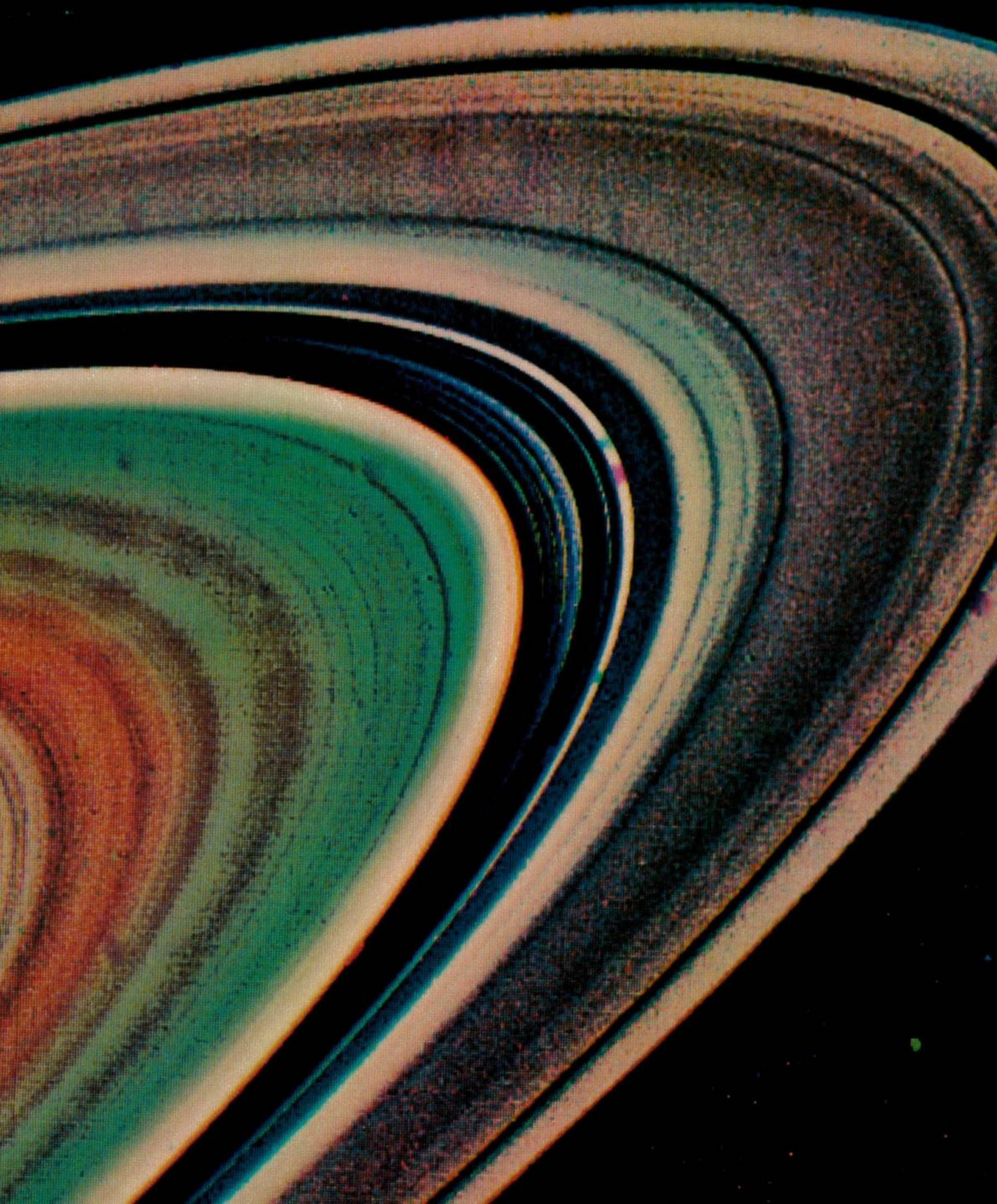
Astronomers thought the Cassini and Encke Divisions were empty — or nearly empty — scoured out by gravitational resonance with a satellite: Mimas in the case of the Cassini Division, and an undiscovered moon for the Encke Division. As a whole, the rings were known to be thin, since they

Left, top: An overview of the F ring and its two shepherd satellites, seen when the inner lapped the outer ten days before encounter. Middle: At one hundred times higher resolution, the F ring resolves into at least four non-braided components. Bottom: At a hundred times again higher resolution, the stellar occultation experiment resolved the brightest strand of the F ring into at least ten components. Right: Voyager 1 showed the coarse bands in this image as tiny ringlets. Voyager 2 revealed ten times as much detail as well as ten times as many ringlets.

Following pages: Subtle color variations — greatly enhanced by computer processing — may indicate differences in the chemical composition of particles in different parts of the ring.







"Trying to understand the data is like trying to drink from a fire-hose."

— Rich Terrile

virtually disappear when seen edge-on from Earth, twice each saturnian year. Although details were lacking, astronomers felt they understood the overall structure of the ring system pretty well.

Pioneer 11 smashed that simple view. In 1979 the spacecraft demonstrated the existence of a very sparse D ring inward of the C ring, and a thin F ring lying just outside the A ring. Pioneer data also hinted at yet another ring: the faint G ring, located beyond the F ring. The spacecraft's simple imaging system — unsophisticated compared to the powerful cameras aboard the Voyagers — showed that even the widest and darkest gap, the Cassini Division, must have material in it. Astronomers waited for Voyager.

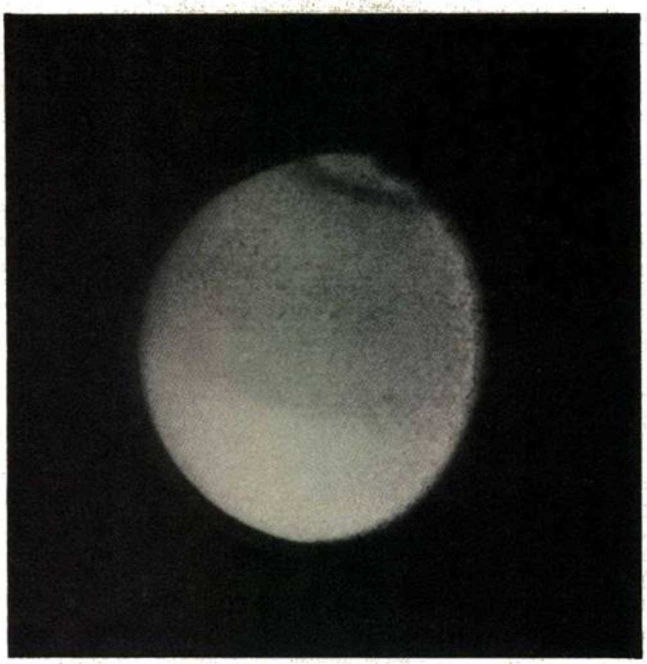
With the Voyager program came the data explosion. The first Voyager confirmed Pioneer's findings. It imaged another ring, the E ring, outward of the G ring. It found an ever-changing pattern of dark spokes on the B ring. Its photographs showed that the rings were actually hundreds — with estimates ranging upward of a thousand — of individual ringlets. And not only did the Cassini Division contain material, it had ringlets and complex detail appearing in a seemingly regular sequence.

Suddenly the old picture was gone. As astronomers struggled with patched-together theories to explain what they were seeing, they shook their heads in amazement. No one doubted that gravitational effects were causing the fine structure, but there were certainly far more details than simple resonances with Mimas or another satellite could account for.

As they mulled over the photographs in the months after Voyager 1's encounter, scientists became convinced that the simplest explanation lay in "embedded moonlets." They postulated that chunks of ice 1 to 20 kilometers in diameter circulated within the rings. These created the fine structure in the rings through a mechanism called "gravitational focusing." Any particle passing too near a moonlet would be perturbed gently away — to an orbit with a longer or shorter period than the moonlet. Thus moonlets would clear paths for themselves.

Enter Voyager 2. With its trajectory soaring higher over the rings than Voyager 1's, and with the Sun's illumination falling more fully on the rings, Voyager 2 could examine some of the most puzzling aspects of the rings in exquisite detail. It would systematically photograph the B ring for spokes. Its pictures showed spokes forming and decaying. Its cameras photographed every bit of the Cassini Division, capturing icy embedded moonlets down to a few kilometers in diameter.

As for the braids in the F ring, scientists hoped they would yield their secrets to the superior resolution of carefully planned picture sequences — but they did not. Worse yet, Voyager 2 showed no embedded moonlets in either the Cassini or the Encke Divisions. Nor did the rings become simpler at higher resolution — a staggering mass of new, finer detail appeared. And there were new questions: what happened to the F ring braids? The parts of the F ring photographed by Voyager at high resolution were not braided. Why did the new ringlet recorded in the Encke Division appear to have an eccentric orbit and even kinks — with no satellites to cause them? How is it that the outer edge of the Cassini Division is eccentric?

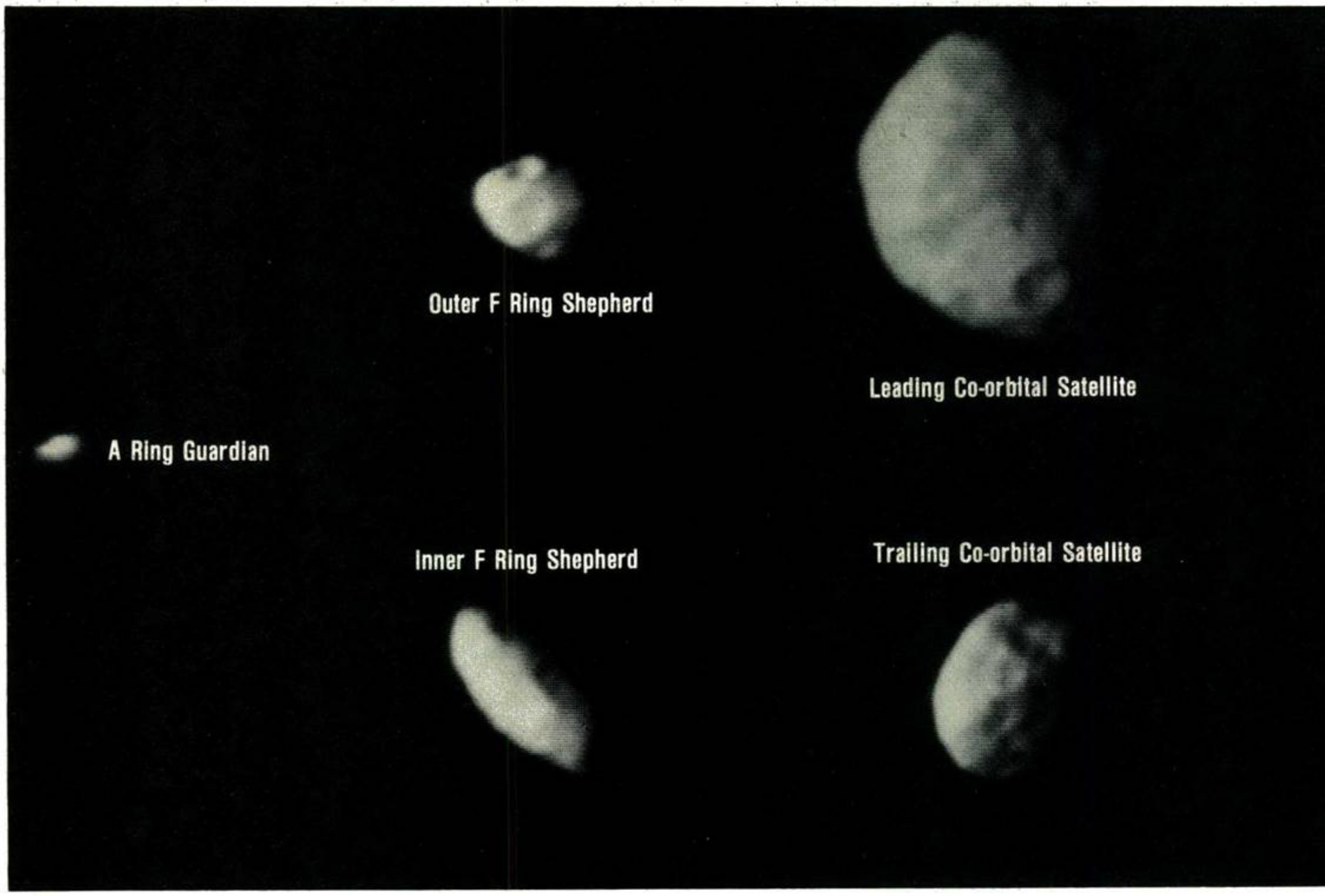


Other mysteries recurred. Voyager 2's radio receivers detected the lightning-like "zaps" observed by Voyager 1 — although not as many. These signals have the radio characteristics of lightning — although they are 100 times more energetic than jovian lightning — and were thought to be connected with the spokes. However, the duration of the signals rules out giant discharges running 10,000 kilometers across the rings, and suggests that a source perhaps 10 kilometers wide may orbit Saturn every 10 hours and 10 minutes in the midst of the thickest part of the B ring.

All the miscellaneous new information about the rings keeps promising some solution — but no one knows what it will be. In many of the gaps, radio occultation data from Voyager 1 show that large particles were spread equally across a gap, but small particles were concentrated at the edges. Or that the rings really are thin — less than 500 meters according to radio data, and around 120 meters according to optical data. Or that in the outer section of the Cassini Division, the average particle size is about 6 meters, with virtually none larger than 12 meters, and very little mass in particles smaller than 10 centimeters. Where does all this lead us? We still don't know.

One of the most important experiments carried out by Voyager 2, a stellar occultation measured with the photopolarimeter, added more detail to the

Left: Sunlight illuminates an orange crescent in this backlit view recorded by Voyager 2 a day after closest approach to Titan, Saturn's largest satellite. Hazes in Titan's massive atmosphere scatter light around the planet and produce a bright blue ring. Above: Titan still displays a darker northern hemisphere, but the polar haze cap seen by Voyager 1 has become a "collar" at about 60° north latitude. A high haze layer extends beyond the limb of the satellite.



already staggering mass of ring data. For over two hours, as the star Delta Scorpii passed behind the darkened rings, the photopolarimeter measured and stored 100 light measurements per second on Voyager's tape recorder for later return to Earth. It amounted to a precision cross-section of the rings, showing where material was and wasn't, and how much material was present.

The stellar occultation provides another crucial link — the precise locations of rings. Where, exactly, is the inner edge of the Cassini Division relative to the 2:1 resonance with Mimas? What is the orbital period of a particle in the Encke Division and how far does it lie from the center of Saturn? Images of the rings made with Vidicon TV cameras are not precise enough to give the accuracy needed to investigate these questions, but the occultation data provide a scale as accurate as the spacecraft navigation.

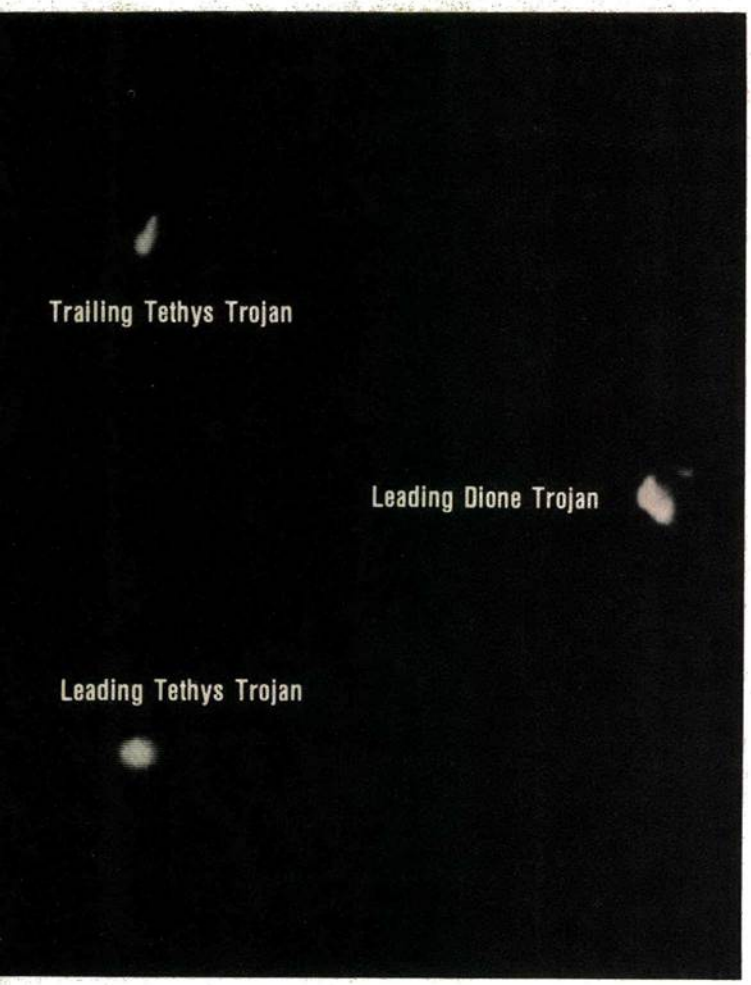
With no trace of the embedded moonlets, scientists began considering alternative — but more complex — theories. One idea competing with the embedded moonlet theory is the "density wave" model. It received a major boost from a series of fine, regularly spaced ringlets and small gaps observed near the Encke Divison by the photopolarimeter. The density wave model suggests that ringlets are created by gravitational resonances with the inner moons. Ringlets are not fixed, according to this theory, but are places where the density of ring particles is temporarily high. Under the perturbations of satellites, the ring particles' orbits become elliptical and clump together into "waves." Although the waves should appear to spiral slowly outward, there is no net transport of material away from Saturn. The waves move; the ring particles remain.

However, neither simple gravitational physics nor gravity waves alone can explain all the features of the ring system. The braids in the F ring and the kinky ringlet in the Encke Division *could* be the result of interactions between the very fine particles that seem to make up these rings and the electric fields, magnetic fields, and particles that also envelop the Saturn system. The large bodies familiar to astronomers are simply not affected by these forces — gravity dominates them entirely — but ring particles considerably smaller than the wavelength of light could be strongly affected.

Although the Voyager scientists have many details to deal with, they're not suffering from any shortage of broad explanations. However, finding which ideas work and which don't will take time. Electrical charges may complicate the picture by braiding insubstantial rings of dust around rings of larger particles not affected by charges. Resonances, for example, could involve interactions with five or more major satellites and seven smaller ones. The physics is certainly beyond simple intuition. Months or even years of computer modeling will pass before we have the first good account of Saturn's rings.

Meanwhile, other ring-related phenomena demand attention. Beginning about 850 kilometers above the ring plane, the signal recorded by the

"Our goal is to understand what's going on."
— Andy Ingersoll



kilometric radio receiver increased thousands of times, then faded as Voyager dropped below the rings. From the nature of the signals, the radio team deduced that the spacecraft had hit tiny charged particles of dust. At a relative velocity of 13 kilometers per second, the dust vaporized on impact, creating an expanding ball of plasma detected by the radio receiver. In other words, Voyager discovered yet another ring — this one exceedingly thin — by colliding with it.

The Moons

While the ring system surprised and confounded the Voyager scientists once again, the moons that Voyager scrutinized generally did not. Although no one expected all of what was found, there were no shocks — rather confirmations of the expectations raised by Voyager 1.

The moons targeted by the Voyager 2 team were Enceladus, Tethys, Hyperion, Iapetus, Phoebe, and the eight smaller "rocks": the A ring guardian, the two F ring shepherds, the leading and trailing co-orbitals, Tethys B and C, and Dione B. The rocks — named for their rough and irregular appearance — are quite bright and are probably chunks of water ice that vary in size from 50 to more than 200 kilometers across.

The A ring guardian appears elongated. The two F ring shepherds are fairly large: the inner measures 140 kilometers by 70, the outer 120 by 100. Both are irregular, and the outer satellite clearly shows at least one crater on its surface. The two co-orbitals are the biggest of the rocks: the leading one measures 220 kilometers by 160, the trailing 140 by 100. Both show approximately circular silhouettes, and photos reveal several craters on each.

Tethys B and C are small — 50 and 60 kilometers in diameter — and have no distinguishing marks. They occupy the same orbit as Tethys, but lie 60° ahead and behind it in its orbit. These satellites were discovered from an Earth-based observatory after the Voyager 1 flyby. Their orbital positions, known as (L_4) and (L_5), are gravitationally stable. Particles that wander into them will likely be caught and remain there indefinitely.

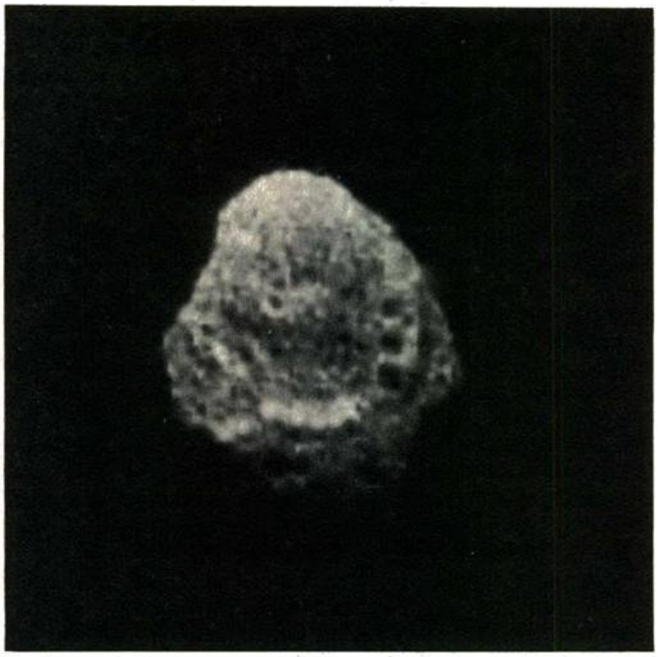
Dione B — 60 kilometers in diameter and sporting a large crater — is in Dione's (L_4) position (60° ahead of the moon); the trailing position (L_5), however, remains empty as far as Voyager 2's cameras could determine.

Enceladus (500 km diameter) came as a delightful surprise. Voyager 1 had shown it to be very bright, smooth, and largely made of ice, and everyone expected an "active" moon. It was. From close up, it reveals a surface covered with grooves that look remarkably like those on Ganymede — strangely deformed craters, and regions of long cracks. Astrogeologists quickly discerned at least three types of terrain: moderately cratered surfaces, ridged cratered plains, and smooth plains. The oldest parts — moderately cratered surfaces — are about as old as the youngest terrains on Dione. The youngest areas, the smooth plains, are 100 million years old at most. Because of its geological youth, scientists think Enceladus has a warm, active core.

How could such a small iceball be warm? Since large bodies hold the heat of their formation and rocky bodies are warm from radioactivity, small, icy Enceladus should be cold, primitive, and un-evolved. But Enceladus lies in an orbital resonance with Dione, which keeps it in an eccentric orbit. Tidal friction heats it as it follows its elliptical path around Saturn alternately coming closer and moving away. (The volcanically-active jovian moon Io gets "pumped" in the same way by Jupiter and Europa, but no puffs of gas come from Enceladus. It is still cold enough that its sole geologic activities are faulting and melt-erasure of features on its surface.) Unfortunately, the scan platform failure denied scientists the opportunity to make high-resolution mosaics of Enceladus.

The next moon out is Tethys. Imaged in part by Voyager 1, detailed coverage of this 1050 km diameter body was slated for the Voyager 2 mission. On the way toward closest approach, Voyager 2 took splendid photos that showed a 400 kilometer diameter impact crater on a heavily cratered surface. Moreover, Ithaca Chasma, the great trough first seen by Voyager 1, continues around the satellite, encompassing 260° of its circumference. As they had for Enceladus, mission planners had scheduled a mosaic of high resolution photographs of Tethys' surface. Again, the scan platform carrying the cameras was jammed and the imaging team received only one partial frame — a chance hit.

Since Titan, by far the largest of Saturn's satellites



Above: Hamburger-shaped Hyperion, roughly 360 kilometers in diameter and 210 kilometers thick, is cratered, irregular, and icy. Because its rotational axis does not coincide with a stable gravitational position, astronomers suspect that Hyperion may have been jostled by a recent impact. Right: The cratered northern hemisphere of Iapetus shows striking contrasts of light and dark. The lightest surfaces are as white as snow; the darkest resemble fresh asphalt.

at 5150 km in diameter, was not a prime target on this encounter, Voyager 2 passed about 1.2 million kilometers from it. Despite this distance, the cameras recorded some changes in the titanian atmosphere. The north polar hood discovered by Voyager 1 had become a band, and more evidence was uncovered for banded structure in the clouds. But scientists were a bit disappointed when they did not find the atmospheric features that would have allowed them to clock the high-speed winds they predicted.

> **"For an exotic body with such exotic effects as Iapetus, we have to open our thinking to all sorts of possible phenomena."**
>
> — Harold Masursky

Hyperion, orbiting beyond Titan, was hardly seen at all by Voyager 1 — it simply appeared as an oblong mass in the images. Nobody expected it to reveal more than the fact that it was a small chunk of ice. But the photos show that Hyperion has the shape of a dented hockey puck — roughly 360 kilometers across and only 210 thick.

Surprisingly, Hyperion's long axis is not pointed toward Saturn — it is at an angle. This may indicate that something large slammed into Hyperion and knocked it out of alignment. If this is true, the impact may have occurred recently because the position of its axis indicates the moon has not yet re-established its dynamic equilibrium with Saturn. However, Hyperion orbits a long way from Saturn, where the tidal effects are weak, and it is possible that the satellite's imbalance dates from the time when it formed from the "Saturn nebula" four-and-a-half billion years ago.

Voyager 1 gave us some clues about the centuries-old riddle of why one hemisphere of Iapetus is darker than the other, but the photos of the 1440 km diameter moon weren't sharp enough to show surface features clearly. Voyager 2 came over 2½ times closer, and this time individual craters on the body's surface were sharply defined. The leading hemisphere is dark — darker than asphalt pavement — while the trailing hemisphere has the brightness of slightly dirty snow. Nothing else in the solar system is known to have such contrast in its surface materials.

No one knows where all the dark material came from. Did it gurgle up from inside or was it strewn across the landscape from above? Solving the enigma of Iapetus would be a lot simpler if its surface material came from outside — after all, how can a moon that's made of solid ice ooze out jet-black matter? But photos of the light hemisphere show craters with dark floors, and along the edge between the light and dark regions lie craters that look as if they have been flooded by dark material. To add to the puzzle, there's a large dark ring with a light-colored center — without any obvious vertical relief! One of the problems with explaining Iapetus' mottled appearance is that both internal and external sources may have caused it. Another problem is that the solution that scientists hoped would appear in Voyager 2's higher resolution images did not materialize.

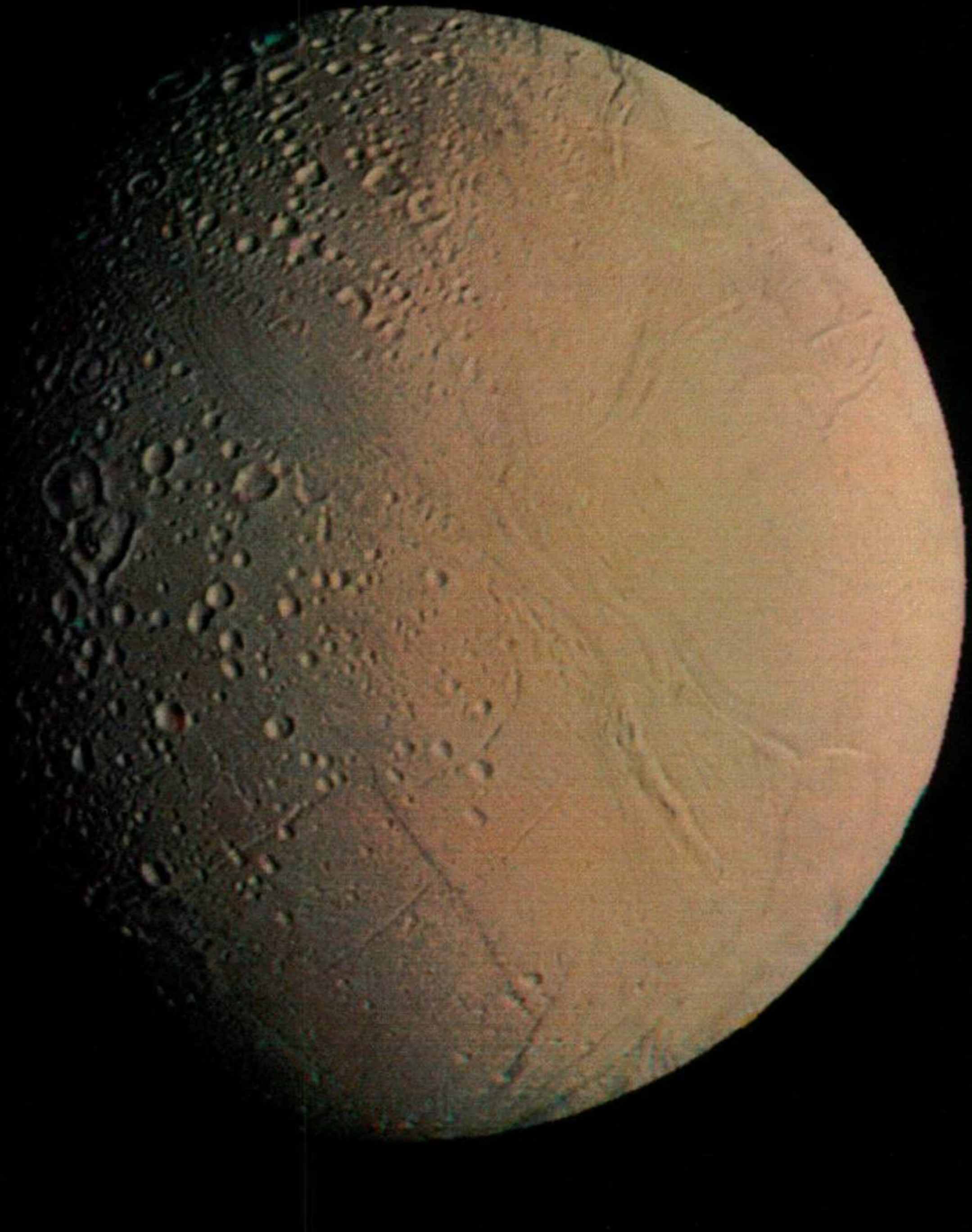
Phoebe, Saturn's most distant satellite, is probably a captured asteroid. The 240 kilometer diameter body circles the planet once every 550 days in a highly inclined, eccentric, and retrograde orbit. Apart from Phoebe, all the satellite surfaces we can

Voyager 2 Saturn Photo Data

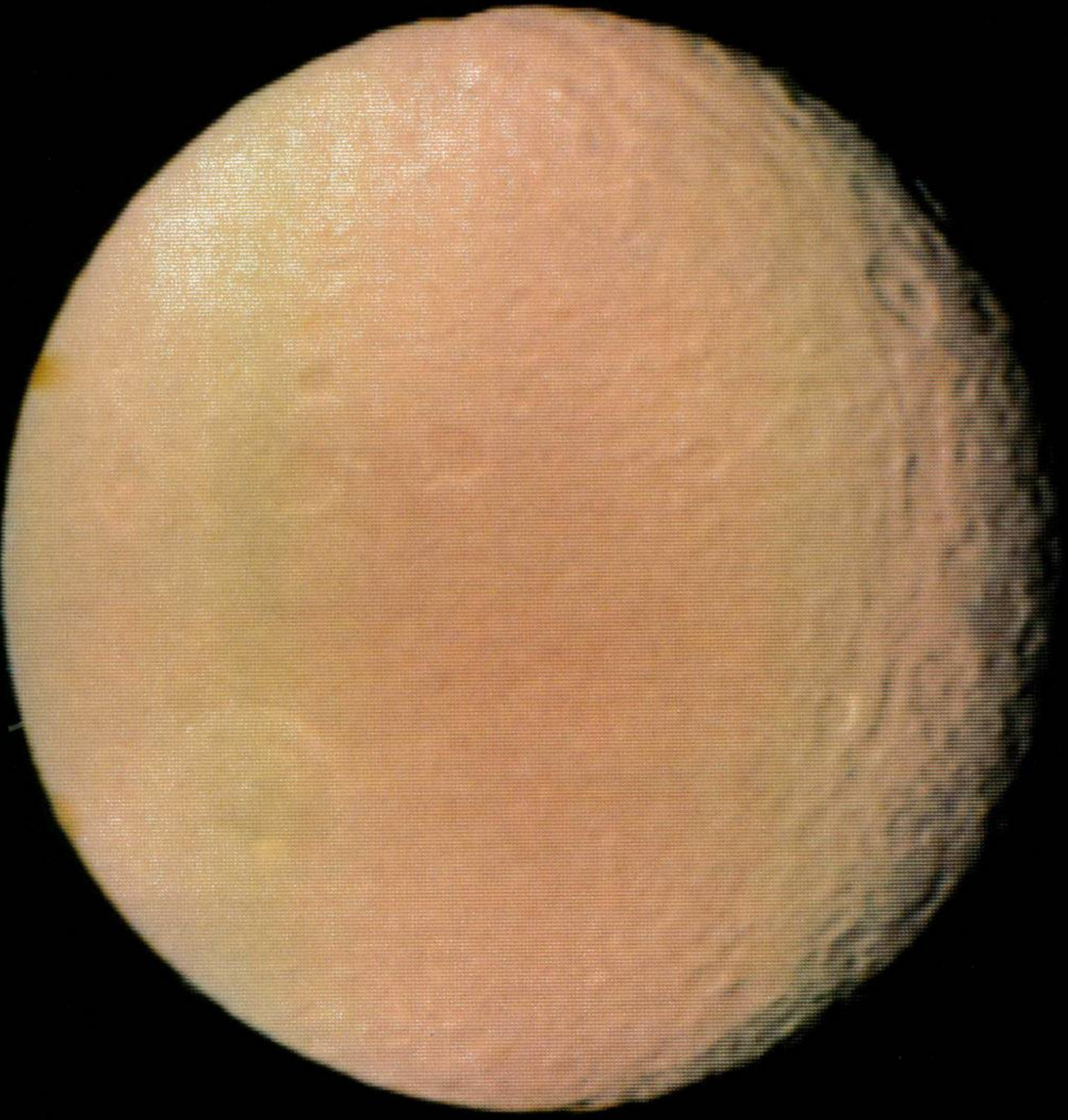
For each picture shown on these pages, the table below gives the date and the distance from Voyager to the subject. The picture number is NASA's designation and specifies the image in their files.

Page	Date	Range (Km)	Picture #
Cover	Aug. 11	13,900,000	P-23907
4-5	Aug. 23	2,800,000	P-23942
6-7	Aug. 4	21,000,000	P-23887
8	Aug. 25	633,000	P-23947
9	Aug. 23	2,500,000	P-23937
10	Aug. 15	10,700,000	P-23910
11	Aug. 20	6,400,000	P-23919
12	Aug. 19	7,100,000	P-23915
13	Aug. 19	7,100,000	P-23922
14	Aug. 20	6,500,000	P-23917
15	Aug. 22	4,000,000	P-23925
16-17	Aug. 26	103,000	P-23964
18 (top)	Aug. 15	10,500,000	P-23911
18 (middle)	Aug. 26	103,000	P-23962
18 (bottom)	Aug. 26	N/A	P-23960
19	Aug. 25	743,000	P-23946
20-21	Aug. 17	8,900,000	P-23953
22	Aug. 25	907,000	P-23949
23	Aug. 23	2,300,000	P-24067
24-25	various	various	P-24061
26	Aug. 23	1,200,000	P-23932
27	Aug. 22	1,100,000	P-23961
28	Aug. 25	594,000	P-23948
29	Aug. 25	119,000	P-23955
30	Aug. 29	3,400,000	P-24062

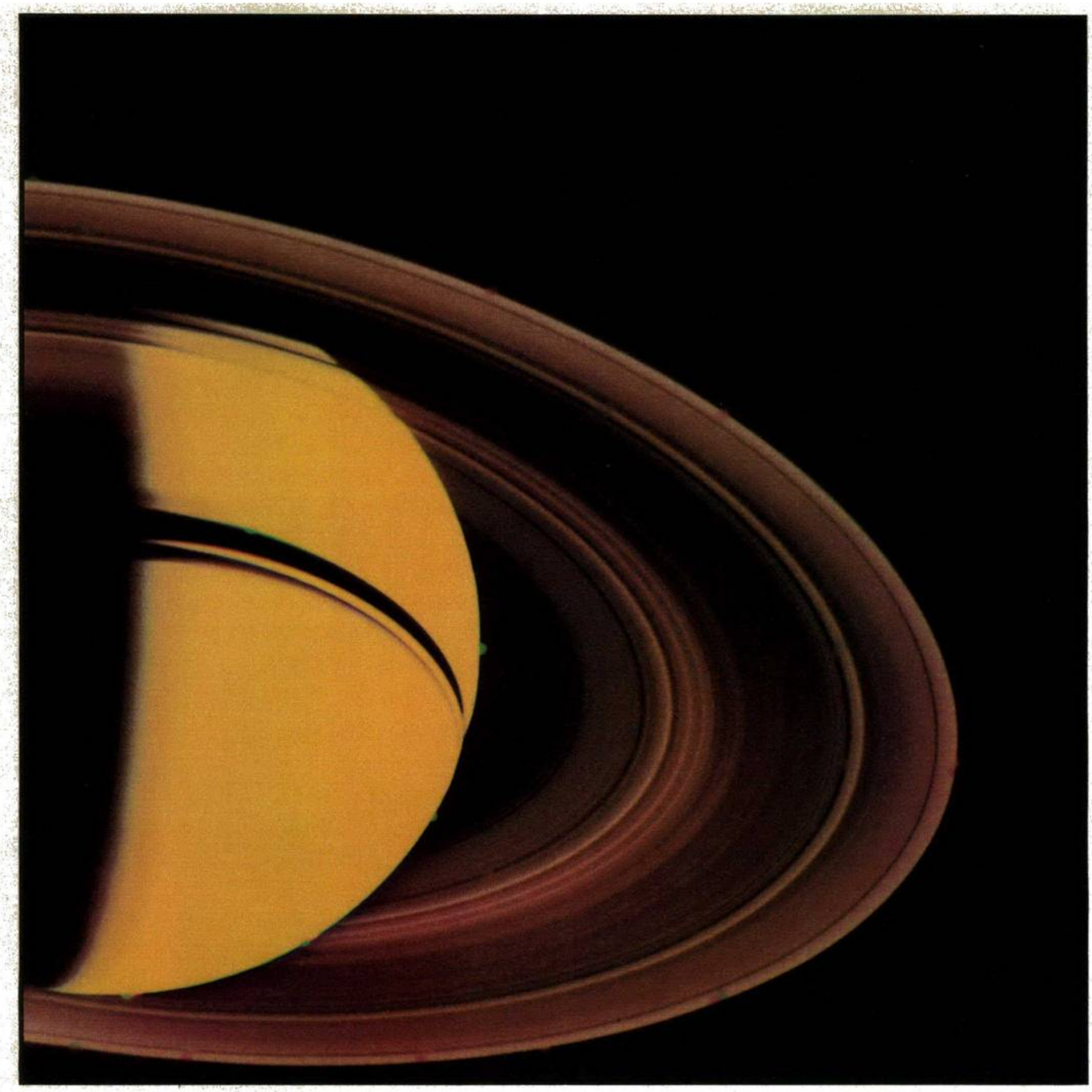
All photographs courtesy of JPL and NASA.



Enceladus is a fascinating body. Too small to have generated much internal heat, it is nonetheless geologically active, possibly driven by tidal heating. Its surface displays at least three different types of terrain, ranging from old cratered regions to grooved areas similar to those on Ganymede.



Tethys shows two distinct kinds of terrain — bright, heavily cratered "ancient" regions and darker, less-cratered areas that must have been modified after formation. Tethys is scarred by a giant trough that runs three-fourths of its circumference.



see are icy — either clean or dirty. Phoebe's surface appears to be dark reddish rock resembling, on its reflectance curve, carbonaceous chondrite meteorites. The satellite's shape is generally circular. This suprised scientists somewhat, as they expected an object of Phoebe's small size to be more jagged and irregular. The tiny satellite may also be the source for the dark material on Iapetus — since matter chipped off Phoebe by an impact would tend to accrete on the leading hemisphere of Iapetus.

For the Voyager teams, years of analysis lie ahead. Many of the questions provoked by Voyager's flyby will be answered within a year or two, but others will not. The Space Telescope will observe Saturn's weather patterns, and should be able to monitor, albeit indirectly, spoke activity within the B ring. Unfortunately, with a resolution of 400 kilometers at Saturn, it will shed little light on other questions about the ring system, the satellites, or the complex and intriguing interactions between the large bodies of the Saturn system and the particles that surround them.

If we do return to Saturn many years from now, mission plans will certainly call for swinging our newer, more sophisticated spacecraft into orbit about this second gas giant to stay for a year or more. Then we will probably drop probes into the atmospheres of Saturn and Titan, and continue the reconnaissance that Voyager has so tantalizingly begun.

As it left the ringed planet with its scan platform back in limited operation, Voyager 2 radioed this beautiful image of Saturn back to Earth. We see the dark underside of the rings and the brilliant crescent Saturn that is never visible from our own planet. From this angle, the B ring appears dark and reddish, while the Cassini Division and the C ring shine brightly.

Come explore a comet.

Halley's Comet returns in 1985. The Europeans, the Soviets, and the Japanese are readying spacecraft to meet it. Of the technological powers,

only our nation plans to watch from afar. Why? Our space program is dying.

Over the last decade, NASA's purchasing power was slashed again and again while the rest of the federal budget mushroomed. Twice NASA tried to get funding for missions to Halley's, and twice the budget cutters looked at the dollars and not at what they'd buy. Now the only U.S. representatives at this comet will be the few American scientists associated with the European mission. And it doesn't appear that our government will even fund them properly.

Our space program has strong supporters in the government who could add a Halley Intercept Mission (HIM) to NASA funding. For them to do so in this budget cutting year, however, they need proof to show their colleagues that the public supports space exploration.

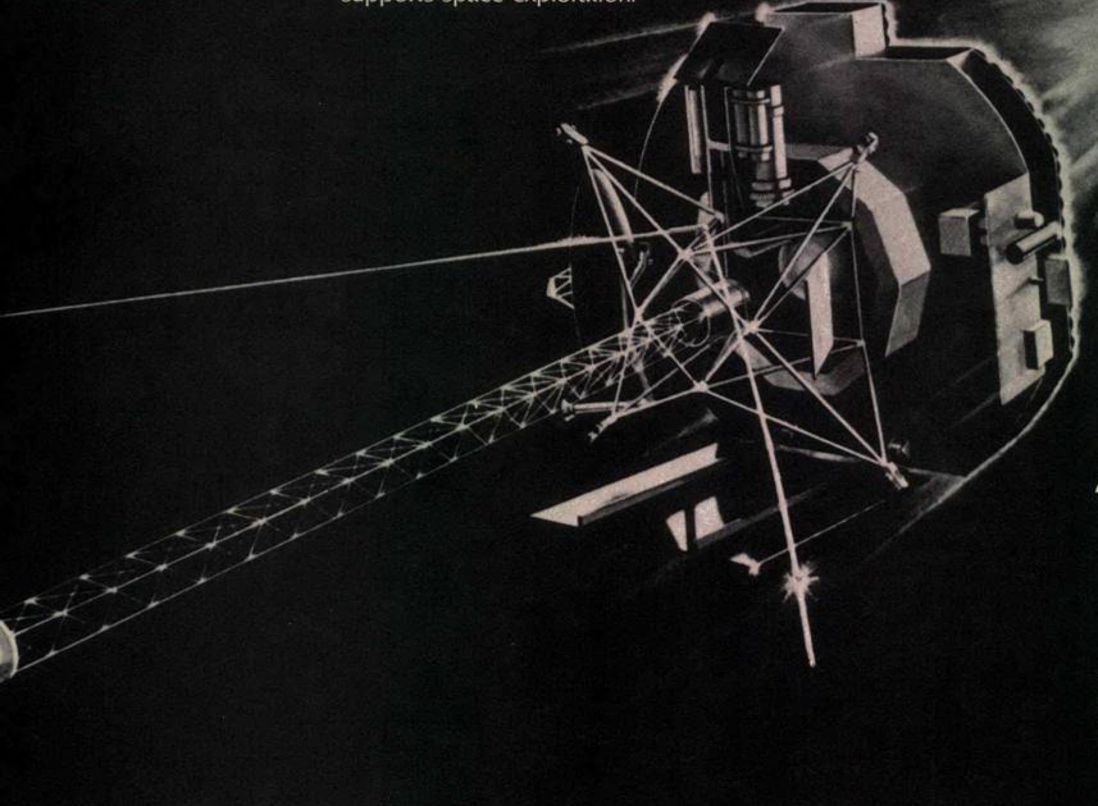
Last year 10,000 people used the Viking Fund to begin giving that proof. They dug into their pockets and gave an average of $10 apiece to support one starving project: the Viking lander on Mars. Today, their money is helping pay the costs of collecting and analyzing Viking's data.

Now the organizers of the Viking Fund announce the Halley Fund. Its goal: Show popular support for HIM by actually helping pay for it. By sending a few dollars to the Halley Fund, you can let the politicians know that you want an American mission to Halley's comet. We'll see that your money helps pay for HIM. And if the mission doesn't make it into the budget, your money will support American scientists associated with the European probe.

At stake is more than America's prestige. Even with other nations sending probes, the scientific value of a sophisticated American probe is unquestioned. The real question is whether the U.S. has the resolve to explore the solar system.

So come explore a comet.

Send your tax deductible contribution to the Halley Fund ($1 minimum), and you'll receive regular updates on the plans of all nations to explore Halley's comet. Don't delay. If Congress doesn't add money to NASA's budget for HIM this summer, your next chance to explore Halley's will come in 76 years.



And save our space program.

THE
HALLEY
FUND

Dept. A • 3033 Moorpark Ave.
Suite 27
San Jose, CA 95128

ASTRONOMY FORUM

Observing for Pleasure

An amateur astronomer generally spends his first couple of years finding out what kinds of objects there are in the sky, where they are located, and how to observe them. But what does he do next, when he is no longer a beginner? Many of the people who write about amateur astronomy assume that the necessary next step is to embark on an ambitious program of scientifically useful observations, with concomitantly ambitious expenditures of time, effort, and money. But there is an alternative: to observe for pleasure.

The late nineteenth century abounded with books titled *The Pleasures of the Telescope*, *Astronomy with an Opera-Glass*, and the like, whose authors thought of amateur astronomy as an essentially aesthetic experience. By the mid-twentieth century, such books and such ideas had become rare. But there are indications that, over the past decade, observing for pleasure has begun to make a comeback.

Deep-sky observing, which has the least to offer in scientific value but the most in aesthetic value of all the branches of amateur astronomy, has become markedly more popular. The 6-inch f/8 Newtonian, the traditional amateur telescope — because it was considered the minimum instrument for "useful work" — is being displaced by a variety of smaller and more convenient instruments. But the philosophy of observing for pleasure is seldom discussed explicitly.

Practically all of us started observing not because of a desire to contribute anything to science, but because of the feeling of wonder that we experienced in looking across the vastness of the universe, and the sense of awe that came from discovering the regular pattern of celestial events.

When I think of what I have enjoyed most in astronomy, my thoughts don't turn to my most sophisticated drawings of Saturn or photographs of Jupiter, but to feelings I had during my earlier explorations of the sky: The solitude of evenings at the telescope, the majesty of distant galaxies hanging silently in space above the bustle of life on Earth, the birth of stars in the glowing gas clouds of Orion, and the regular circling of satellites around the familiar orb of Jupiter. I reflect on the excitement of discovering, on several spring evenings in sixth grade, that a conspicuous group of three stars appeared in the same place every night, that they were in fact the belt of Orion, and that the various motions of the sky were regular and made sense.

This initial feeling of wonder cannot, of course, be preserved. Time marches on. But the path it points to can be followed. We can at least avoid getting sidetracked.

Perhaps the most enticing side road is the lure of the telescope. This is what has overcome the amateur who finds himself spending more and more time calculating the capability of his equipment, devising ways to improve it, and drooling over the notion of better equipment — and less time actually observing.

It is easy to imagine this person's thoughts: "If only I had a Quantamax-14, I could see Pluto." He has never seen Neptune. "Ah, the deep-sky photography I could do with a Schmidt camera." But what about the deep-sky photography he hasn't done with his telephoto lens? The patience, self-discipline, and creativity of the observer are usually the weakest links in the system.

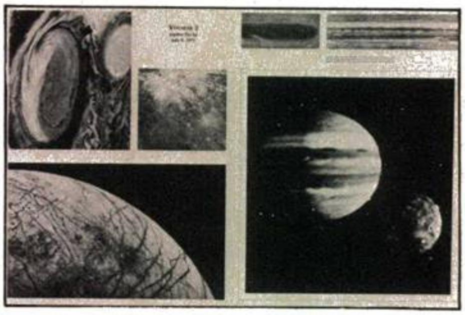
The telescope always represents a compromise between cost, capability, and convenience. But amateur astronomers — including myself in my earlier days — tend to ignore the last of these. Setting convenience aside, the best compromise between cost and capability is generally a 6-inch or larger Newtonian on a medium-duty mount. This is what I bought about ten years ago. I had to carry the thirty-pound mount out into the yard and then attach the bulky telescope to it every time I wanted to observe. The tube itself was so bulky that I often banged it against doorways or furniture, knocking the mirror out of collimation. Soon I tired of having to go to all this trouble, and I stopped making much use of the telescope. Long before I had explored the full range of its capabilities, I retired it.

When I got back into astronomy recently, I chose a portable 4-inch RFT. I can't see as much with this telescope as I could with the other, but all things being equal, I can carry it and its tripod around without any trouble, travel with it to better observing sites, and set it up anywhere on five minutes' notice.

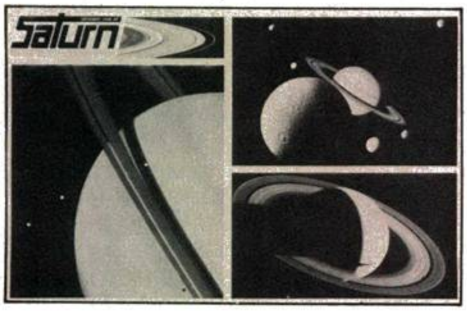
Another side road — not quite as far from the main track but still perilous — is preoccupation with technique. This has its counterparts in other hobbies, for instance, the coin collector who initially saw coins as objects of art, but now sees them as filler for slots in an album. Among amateur astronomers, the technical side road is similar to the equipment side road except that it centers on the capability of the observer rather than the telescope. This observer checks off all the Messier objects in his logbook as quickly as he can, and

Complete Your Fly-By Poster Collection with Saturn 2

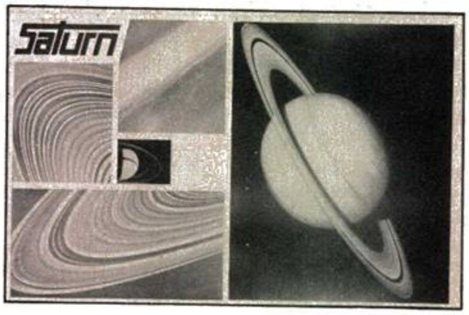
JUPITER 1. Images from Voyager 1 of the Red Spot, floating satellites against the planet and close-ups of the fabulous Galilean moons.



JUPITER 2. Six more unduplicated photos of the miniature solar system from Voyager 2. A perfect complement to the Voyager poster at left.



SATURN 1. The jewel of the solar system reveals its hundreds of rings, radial spokes and curious collection of satellites.



SATURN 2. Stunning images of a giant among planets — with a mystery and beauty all its own.

With the publication of Voyager 2 at Saturn, ASTRONOMY's Fly-By series is now complete. Each full-color poster in this striking collection is made from the best NASA images and measures 22" x 34". Purchase them individually or as a complete set commemorating these historic journeys.

$5.95 each

Set of 4 $18.80

(Save $5.00)

All posters will be shipped immediately upon receipt of order.
Posters are shipped in sturdy tubes to arrive unwrinkled and ready to hang.
To order, specify Flyby poster by planet and number or set on the Astromedia order form bound into this magazine.

Voyager Fly-By Poster Series

doesn't pause to look at the details — all galaxies deserve to be stared at for a full fifteen minutes.

He talks as if double stars were created for the purpose of testing optical systems. He curses the seeing conditions. If he is an astrophotographer, he has tested fifteen different films without learning much about any of them because he hasn't stuck with any single film long enough to become familiar with it.

Avoiding these side roads, these blind alleys, calls for creativity and self-discipline. Among American amateur astronomers, there is a tendency for everyone to want to do whatever the most prominent amateurs happen to be doing at the moment. At the moment, hydrogen-hypered film is in vogue. Before that, it was cooled-emulsion photography of galaxies. There was a time when high-resolution planetary photography was the thing; and earlier still, it was virtuoso mirror-grinding. A good way to keep from getting caught up by the vagaries of fashion is to read the books and magazines from several decades ago (when all amateur telescopes were modest by today's standards) and, as far as your knowledge of the languages permits, to read amateur publications from other countries.

The challenge, of course, is to devise interesting projects that can be carried out with the equipment you have rather than spending your time wishing you had the wherewithal to duplicate someone else's results. Too much versatility can be a hindrance rather than an asset; you may need to "limit your palette" as does the artist who disciplines himself by painting with only one or two colors instead of the full range.

Choose some simple technique and see how much you can do with it. Spend an evening observing without any equipment at all. Look for the elementary kinds of things that you've never gotten around to trying. Have you ever watched a variable star vary? Practice writing descriptions of all the objects you see and compare these with the classic descriptions by nineteenth-century observers such as Webb and Smyth.

Re-enact historic observations, such as Galileo's discovery of the satellites of Jupiter, with your telescope diaphragmed down to the size of his, or try to discover a nebula using the same methods Herschel did. Search for a comet. In other words, contemplate the universe and fulfill what the ancient poet Ovid said was our Creator's first exhortation to human beings:

. . . caelumque videre
iussit, et erectos ad sidera tollere vultus.

"He bade them behold the / heavens
And lift up their faces, standing / straight, to the stars."

Michael Covington
New Haven, CT

Urban Astronomy

As a child I quickly exhausted my local library's supply of astronomy books and magazines. Many of these volumes were illustrated with pictures of excited young people crouched around their telescopes surrounded by farmland or rolling hills that were domed by a pristine night sky. To me such pictures were as alien as Pluto or a view of Saturn from Titan — I grew up in Brooklyn.

At first glance, a city-bound stargazer's position might be likened to that of a surfing enthusiast living in Idaho. But contrary to popular belief, urban astronomy isn't impossible.

Many neighborhoods, to be sure, are unfit for any kind of observation. If you happen to live on a busy street surrounded by high-rise buildings, for example, you'll be lucky to see the night sky at all. But some of us are more fortunate. We live near parks, athletic fields or railroad yards. Where I grew up, I could see the southern half of the sky almost unobstructed from horizon to horizon.

Urban astronomers are a hardy breed, possessing many skills that their rural counterparts seldom think about. It's not easy to catch a glimpse of the rings of Saturn on a breezy night while the planet's image sits precariously between two dancing telephone wires.

Light pollution is also a constant nuisance, and the new sodium vapor streetlamps — taller and brighter than their predecessors — haven't helped matters. But a cagey observer can use the buildings surrounding his vantage point as light shields if he doesn't mind moving his instrument every so often.

Generally speaking, the astronomers of Brooklyn have few opportunities to get a good look at deep sky objects, but there are a few remarkable exceptions. On clear nights, the Pleiades can be observed in great detail. Even the Orion Nebula can be located with a modest-sized instrument. The trick is to wait until the object is at its highest in the sky — that way, despite less than ideal seeing, you'll be observing through the least atmosphere.

But the real action for urban astronomers is right in our own celestial neighborhood, the solar system. Mercury and Venus can be a bit difficult because of their tendency to appear so close to the horizon, but this can be easily remedied by taking your telescope up to a roof. As we move to objects farther from the Sun and higher in the sky, the task becomes simpler. Our odds quickly increase for evading obstructions and looking through fewer miles of dirty atmosphere.

Even though these drawbacks are significant, some of the greatest sources of frustration are frequently ground-based — not in the sky. To the uninitiated passerby, a reflector with a clock drive might look like some fiendish weapon of mass destruction. Refractor users, whose instruments more closely resemble the common conception of the word "telescope" are also not immune to overreaction; they're likely to be accused of being peeping Toms. Either way, a city stargazer shouldn't be too surprised if a police car appears shortly after he sets up his equipment.

Sooner or later, however, the law will discover the true nature of your intentions. In fact, they might make your sidewalk observatory a regular stop on their nightly rounds. There's nothing like a view of the martian polar caps or the Galilean satellites of Jupiter to break up the monotony of a quiet night's patrol.

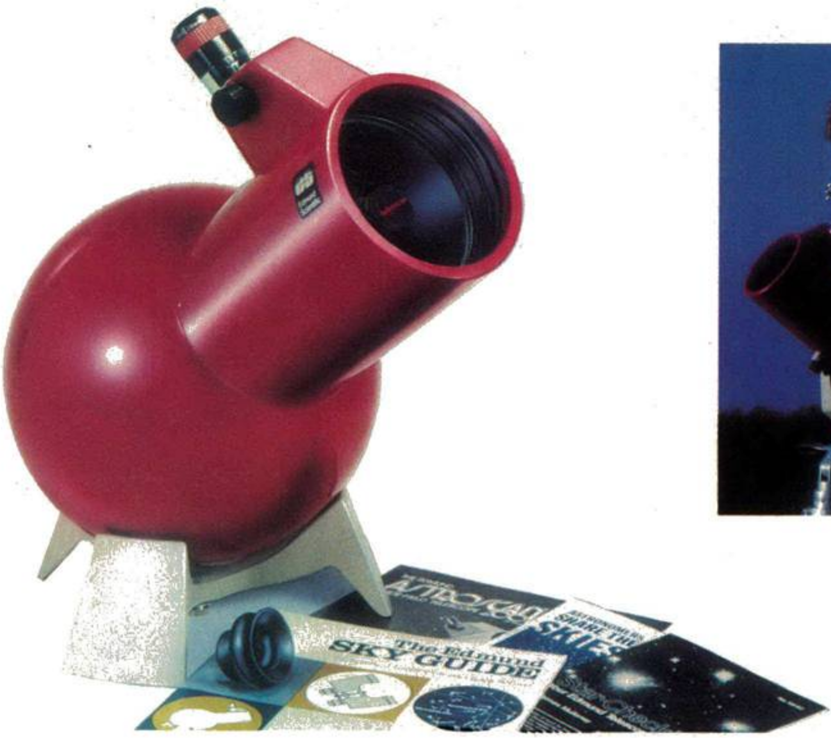
While I have no idea how many urban astronomers there are, I believe that the results of a survey would be surprising. In one way, despite all the hassles of less than ideal seeing conditions, we do have an important advantage. Pedestrians are often intrigued, and hardly a clear night will pass without curious onlookers approaching you. They often watch from a shadow for a minute or two until they've decided you're not dangerous. Then they'll come a little closer to ask what you're doing.

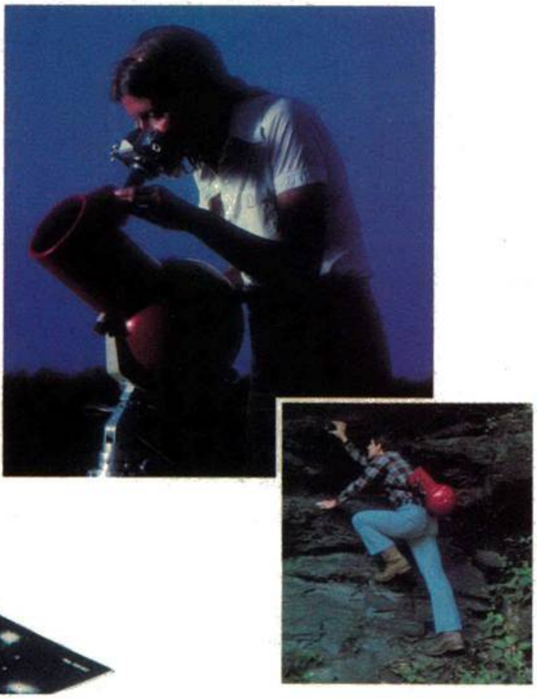
Start them off with something very familiar, like the Moon. Then show them something that they've never experienced.

"You see that star up there?"

"Yeah."

"Well, it's not a star. It's the planet Jupiter, and if you'll have a look, *you'll see four of its moons* and a giant storm that could swallow up a planet the size of Earth."





Journey Through The Universe With The Astroscan® 2001

A Telescope Like No Other

The Astroscan® 2001 Telescope is your star ship on a fantastic journey through the wonders of a spectacular Universe.

The first truly unique beginner's telescope, Astroscan introduces you to hassle-free stargazing with a wide brilliant field of view and power enough to take you to the darken caverns of the moon, race through firery nebulae, and hover above the glittering rings of Saturn.

Innovation. . .The Astroscan's incomparable design has made it just about the most fun-to-use telescope ever designed. Yet, it has gained the reputation as a proven, respected instrument used by serious amateurs and professional astronomers the world over as a delightful second telescope. It offers you the thrill of simplified stargazing at a truly down to earth price.

Unique Prize Winning Design. . .Winner of the 1976 Industrial Design Award, Astroscan's space age design eliminates cumbersome and complicated mounts typical of most telescopes. Simply set it on a flat surface and you're instantly ready to observe. It's simple enough for even your child to use the first time out.

Wide Field Of View. . .the Astroscan is a 4⅛-inch clear aperture Newtonian rich-field telescope, providing breathtaking 3° field of view (that's 6 full moons wide). The Astroscan is literally your own window to the universe.

Precision Optics. . .The heart of the Astroscan is an exquisite primary mirror, ground, polished & tested in our modern optical facilities to perform at theoretical limits possible for its size. The Astroscan's spectacular images over a wide, bright field, makes finding celestial objects fun and easy!

Portable & Durable. . .A lightweight 10 lbs., Astroscan is easy to move about—yet extremely stable. Take it anywhere—its tough impact resistant body is made for a life time of active use.

Vertility. . .With a full line of accessories, the Astroscan keeps pace with you as your interest grows.

You Be The Judge. . .Order today and take a full 30 days to decide. Take it out on your balcony or in your back yard and see for yourself the wonders of the universe through the Astroscan. If you're not 100% delighted, return and we will promptly refund your money.

Order Today. The Astroscan comes in two models. The Astroscan® No.2001 as outlined in the specifications to the right. . .ready to use for your journey through space for only $209.00; or the No. 2008 identical but with a special straight through image erector making it ideal for ground-level viewing as well as an astronomical telescope for only $239.00.

Either way, you'll own the most remarkable telescope ever designed. Comes complete with full instructions and full one year warranty.

Specifications

Primary Mirror: 4⅛" (105 mm) clear aperture f/4.2, 17½" (445 mm) f.l., parabolic, ⅛ wave, Pyrex aluminized & overcoated.
Primary Mount: Factory pre-collimated & fixed for precise alignment.
Secondary Mirror: Elliptical 1.5" minor axis, ⅛ wave flat, aluminized & overcoated.
Secondary Mount: Diagonal support mounted directly to anti-reflection coated optical window, which protects system against dust and moisture.
Finder: Sturdy aluminum, sight style.
Eyepiece: 28 mm e.f.l. RKE®, 45° apparent field, standard 1¼" OD barrel.
Magnification: 16X with 28 mm RKE®, 75X with optional eyepieces & Barlow.
Field of View: 3.0° at 16X.
Focuser: Smooth, positive-grip rubber roller type.
Weight: Scope 9.4 lbs., base 2 lbs.

ORDER TOLL FREE!

Credit card holders use our toll free ordering number or send check for full amount and 5% sales tax in N.J., plus $3.50 delivery.

(800) 228-2606
In Nebraska (800) 642-8777

Edmund Scientific
8210 K-22 Edscorp Building
Barrington, New Jersey 08007

"No kiddin'?"

"No kiddin'. Go ahead. Have a look."

Your visitor bends toward the eyepiece. This is the best part — the moment of truth. You can always tell when they are finally focused because a look of childlike wonder spreads across their faces. Maybe, if they ever stopped to notice it at all, they thought that Jupiter was just another point of light in the sky. Now they know it is a world. As you move around to other planets, maybe a star cluster or two, they'll be awed by a night sky they took for granted until now, and come away from the eyepiece full of questions.

They might ask how you got started, how much the telescope cost or even for the name of a good basic astronomy book. As you watch them walk into the night you'll know they're hooked.

Before long, they too will set up a telescope on a dark sidewalk to explore the sky and share it with others.

Paul Contursi
Brooklyn, NY

An Interview with Dr. Hans Vehrenberg

Hans Vehrenberg is the publisher of *Sterne und Weltraum*, a German astronomical magazine. He has published several star atlases and an album of deep-sky photography.

ASTRO: Dr. Vehrenberg, where do you think amateur astronomy is headed in the future?

Vehrenberg: That is a difficult question to answer. Most amateurs, I believe, still find themselves doing much the same things amateurs did twenty or thirty years ago. But then, professional and amateur astronomy were not as far apart as they are today.

ASTRO: Do you mean to say that there is a greater distance between the two groups now than there was in the past?

Vehrenberg: Definitely. Professional astronomy is so specialized that professionals in different fields of astronomy do not understand each other any more. They have to attempt to find common denominators of communication. Amateurs have been unable to keep pace with these events. Amateurs still live in the time when professionals were in accord with each other and had an opportunity to interact with star-devotees. Those times are over.

ASTRO: Would you tell us what it was like when professional and amateur astronomers were still communicating?

Vehrenberg: Time was when most who went into astronomy for a career started out by being amateur stargazers, which made communication easy and natural. Today, although some astronomers still come from the natural sciences, physics makes up most of the background of our professionals — the astrophysicists. Few amateurs can readily understand them — and they, of course, don't understand the amateurs.

ASTRO: But wouldn't you agree that the amateur has also made progress? Remarkable photographic tools, for example, which were unthinkable a mere twenty years ago, are used today.

Vehrenberg: Quite true. In the past, however, starlovers had to build all their own equipment. This gave them a certain basic expertise. Today anyone can go and purchase a telescope. Still, if an amateur astronomer is so inclined, he can use such tools, whether homebuilt or purchased, to participate in sky surveillance programs for which professionals no longer have the time.

These are important endeavors now, and they will remain so in the future. It is a matter of available time, and astronomy is a time-intensive pursuit.

ASTRO: I, for one, experience acute feelings of inferiority when I read some articles in astronomical publications. Often, I am totally unable to understand any part of them.

Vehrenberg: You shouldn't feel too bad. Just the other day, the editor of *Sterne und Weltall* [a German astronomical monthly] told me that he himself no longer understands most of the articles which he publishes even though he holds a Ph.D. in astronomy.

ASTRO: And yet he publishes them?

Vehrenberg: Yes, he publishes them without understanding them. That is somehow alarming.

ASTRO: Who does he think will understand the material in his magazine?

Vehrenberg: Well, to my knowledge, only a select group among the specialists in the field concerned. But imagine where this leaves the amateur!

ASTRO: Might observational astronomers feel that with telescopes about to be launched into space, earthbound observatories will become relatively useless — and ground-based observers, along with them?

Vehrenberg: Fortunately the starlover need not set himself to any task he does not wish. He need never feel unfulfilled. In that sense, amateur astronomy in the future will be as it always was, a wonderful hobby. Anyway, I think you shouldn't ask a seventy-year-old man about the future.

ASTRO: Since it is dark now, let's step outside for a moment. I'd like to show you an image intensifier which I just acquired. It is a three-stage type. Look, what do you think of it?

(Dr. Vehrenberg looks through the instrument, holding it comfortably in one hand. He surveys a pitch-black garden.)

Vehrenberg: This is fantastic! Here is one future for amateur astronomy — whatever this costs now, it is bound to become less expensive as soon as more of these are built. This is simply fabulous! I can see everything as if it were daylight. Have you used this on a telescope?

ASTRO: Only once so far. At the first focus of the 14-inch Schmidt-Cassegrain, I photographed the Sombrero Galaxy in three minutes.

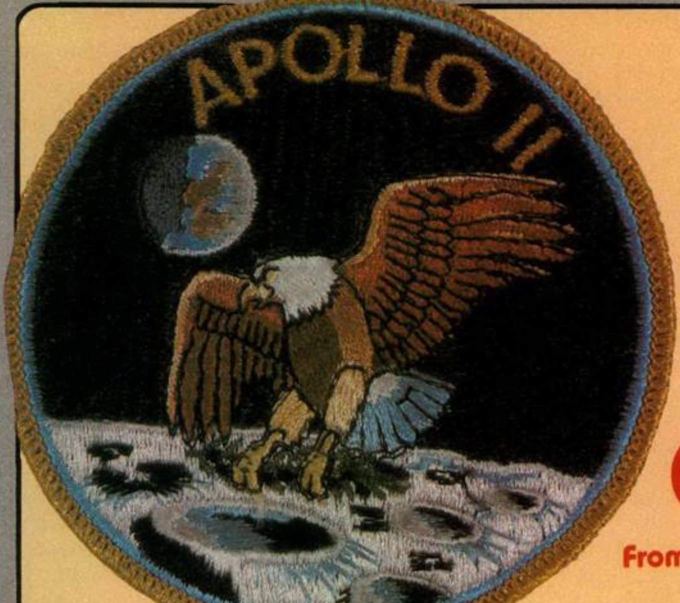
Vehrenberg: And you ask me about the future of amateur astronomy? Where before could an amateur do useful galaxy surveys? With repeated, albeit long, photographic exposures, you could now take a whole series of useful exposures in a few hours — then check or blink them for supernovae. This will not reduce the ever-increasing distance between professional and amateur, but from time to time the professional will have to take time out to study the findings of amateurs.

ASTRO: For you, the Schmidt camera was the main timesaver.

Vehrenberg: Yes, I still favor it. However, I seem to be spending more time in the darkroom processing and generally working on my photographs than I spend at the telescope. But when I am in my observatory, photographing, I forget my daily problems. I feel myself becoming part of the universe. I listen to good music and am completely at peace. In this regard, the amateur — I mean the real starlover — may become unique.

ASTRO: Would you tell us more about that please?

Vehrenberg: Professional astronomy and professional astronomers have become a part of a greater apparatus. They depend on ever-increasing technical support from fields such as electronics and sophisticated optics. The working astronomer must carve out a place



OFFICIAL NASA EMBLEMS

From ASTRONOMY

Display these historic full color patches in frames or wear them on a jacket or shirt - either way you'll be proud to show them. Most are full 4" diameter, carefully woven to Government specifications.

4" - $4.95 each 3" - $3.49 each

including postage and handling. Order singly or in sets as shown.

APOLLO MISSION

Apollo **1** (A1), **7** (A7), **8** (A8), **9** (A9), **10** (A10), **11** (A11), **12** (A12), **13** (A13), **14** (A14), **15** (A15), **16** (A16), **17** (A17), **all 4"**

First Lunar landing (LL) 4"
Apollo "A" Mission (AA) 3"
Set of 14 Apollo **$39.95**

SKYLAB

Skylab **1** (SL1), **2** (SL2), **3** (SL3), all 4"
Skylab USA (SL) 4"
Set of 4 Skylab **$12.95**

PLUS

Space Shuttle (SS4) 4"
Space Shuttle Columbia (COL) 4"
Space Shuttle Approach & Landing (SSAL) 4"
Project Viking (VIK) 4"
Gemini Program (GEM) 3"
NASA extended vector (NASA 1) 3"

SPACE SHUTTLE
APPROACH AND LANDING TEST
FULLERTON
ENGLE-TRULY
APOLLO IX
APOLLO XII
BORMAN LOVELL ANDERS
APOLLO
SKYLAB I
APOLLO 15
Columbia
YOUNG
NASA
II
GEMINI
APOLLO XVII
BEAN GARRIOTT LOUSMA
SKYLAB II
FIRST LUNAR LANDING OF MAN
Skylab
APOLLO XIII
EX LUNA SCIENTIA
WHITE GRISSOM CHAFFEE
APOLLO 1
SKYLAB
CARR-GIBSON-POGUE
NASA
APOLLO 16
YOUNG-MATTINGLY-DUKE
PROJECT VIKING
MISSION TO MARS
VII
SCHIRRA-EISELE-CUNNINGHAM
APOLLO 14
Shepard
Roosa
Mitchell

To order please write patch number, name and size, or set name, on order form.

for himself within this vast arena, keep tabs on advances in the field, and learn to make the best use of them. Today, we amateurs have our own astronomical world. Much of this is now lost to the professsional.

ASTRO: Could you tell us about your own astronomical world?

Vehrenberg: Well, astronomy as I once practiced it has come to an end. For instance, it took me twenty years to complete my various star atlases. With electronic amplifiers, future undertakings might take only one-tenth of the time. A device such as this could have allowed me to explore other areas and to attempt additional work on different programs.

ASTRO: If you had unlimited time at your disposal, what pursuits would interest you next?

Vehrenberg: I enjoy introducing others to the wonders of the stars. I'd like to give them support with my books and star-atlases. I also enjoy having visitors in my observatory — even if it means that it will be impossible for me to work on my programs at such times. People do come to visit from all over the world, and I am always happy at being able to help them in one way or another.

ASTRO: Do you regard yourself as an amateur or a professional?

Vehrenberg: Quite definitely as an amateur. I have always been one, and I have always felt happy in that role. That's how I will remain. Amateurs generally should stay in their own domain, or run the risk of being shipwrecked. For myself, in our present world with all its problems, life would not be worth living if I could not look out into the universe to contemplate the purpose of life.

Ben Mayer
Los Angeles, CA

Galaxies

To stand in the night and look at a galaxy must be one of the most mind-boggling experiences a person can have. You see a tiny patch of light — yet you know that it is actually huge. Monstrously huge. Larger than you can imagine. Nor can you imagine the distance that makes the galaxy appear as only a tiny patch.

You look at this patch of light and try to comprehend that it contains billions of stars, that planets and comets and moons may orbit about those stars, that on those planets and moons are billions of mountains and canyons and oceans and craters, that some of those planets are effervescent with life, and that on some of these living planets intelligent beings may be standing in the night and gazing at a tiny patch of light that is our own Galaxy.

You gaze at the patch of light and try to really understand that it holds so much, and perhaps you almost succeed. And perhaps seeing another galaxy helps you see that you too are in a galaxy, that when seen from far away the stars spread all around you form a tiny disk of light surrounded by blackness.

To look at a galaxy can be quite an experience; yet one day I realized that the only galaxy I had ever seen from the outside was the Andromeda Galaxy — one which is close enough to be seen with the naked eye. I knew that other galaxies could be seen without much magnification, and now I wondered why it was that I had never tried to find them. So I decided to look for some.

On a star chart I checked the location of some nearby galaxies. One winter night that was dark and clear, I set out with some binoculars, though I really didn't know if the binoculars would let me see galaxies. I headed away from the lights of the city. As I walked, clouds began trickling across the sky, and by the time I reached the nice dark countryside, they stained half of it.

I sat down at the edge of a meadow. I looked up and found a few spots where galaxies should have been. I raised the binoculars and hunted for one galaxy, but saw only stars and darkness. I began to look for another galaxy, but clouds soon covered the spot. Now the sky was almost completely covered with thick, dark clouds. I waited for it to clear. I waited ten or fifteen minutes, but the sky remained covered and the breeze blew harder and colder, and at last I realized I wasn't going to see any galaxies tonight, and I headed home.

As I walked back toward the city, my mind full of galaxies and disappointments at not seeing any, snow began to fall. Two or three flakes at a time and then more and then many large snowflakes flickered downward from the sky. The air around me was slowly tinted with whiteness. My face tingled with tiny cold touches. The snow steadily grew thicker. Whiteness closed in around me. The shapes of trees and houses became vague behind the flowing whiteness. In the shifting breeze the falling snowflakes gently flowed this way and that; I was passing through one billowing white curtain after another.

At first I wasn't paying much attention to the snowfall, for I was thinking of galaxies and trying to imagine myself riding within a galaxy that was flying through space. But slowly the snowfall penetrated my mind, and I began to see and enjoy it — this ticker-tape parade the heavens throws for its creatures. I looked upward and watched snowflakes emerging from the vague whiteness of the sky and drifting down. And then, as snowflakes flowed past me by the hundreds and the thousands, I saw this as much more than just a ticker-tape parade. The snowflakes were like — galaxies. The tiny white disk of a snowflake was what a galaxy would look like from afar, and the flow of tiny white disks past me was what you would see if you could sit stationary in space for billions of years and watch galaxies flowing away from the Big Bang.

As I stood there watching tiny white disks emerging from the night, I was suddenly seeing galaxies racing through space. As I watched tiny white disks coming and coming without respite, I was seeing galaxies in all their billions. I was seeing the massive prodigality of the universe. I was seeing the universe's creation, for all of these galaxies had crystalized out of the chaos of the Big Bang. I was seeing unbelievable power, for each of these galaxies contained billions of stars furiously pouring out light and heat; yet I was also seeing unbelievable emptiness, for space is so vast that all light and all heat is reduced to a tiny flake of whiteness.

I knew that hidden within each of these tiny disks were billions of planets and moons covered with mountains and canyons, oceans and deserts, craters and glaciers. I knew that within these tiny disks were multitudes of living creatures, and that within a single disk might be millions of civilizations. I watched the galaxies flowing and flowing and endlessly flowing, flowing from the Big Bang outward. And then among a thousand galaxies I saw our own, the Milky Way, and I watched it flying through the darkness, so tiny and frail. As I stood there and watched the galaxies flowing by, I saw the grandeur and the beauty of the universe as I had never seen it before.

I walked home with the opposite of disappointment. I had wanted to see galaxies, and galaxies were what I saw.

Don Lago
Columbia, MO

Naming the Satellites . . . Again

Sir / Between 1600 and 1900 A.D., the major jovian and saturnian moons were discovered by six men: Galileo, Huygens, Cassini, Herschel, Bond, and Pickering. To solve the controversy over how these satellites should be pronounced, we must know which form of Greek these men used when they named their findings.

I, being a mere high school student, will leave it up to the scholars at the collegiate level to find the exact answers; in the meantime, I am providing here a table of possible pronounciations of the various moons, in English, Hellenized English, ancient Greek, and modern (demotic) Greek.

	Ancient Greek	Modern (demotic) Greek	English	Hellenized English
Io	ee-O[1]	ee-O[1]	EYE-oh	EE-oh
Mimas	MEE-mas	MEE-mas	MY-mus	MEE-mus
Enceladus	en-KE-la-dos[1]	en-KE-la-dos[1]	en-SELL-uh-dus	en-KELL-uh-dus
Tethys	TEH-theess	TEH-theess	TEE-thiss	TEH-thiss
Dione	dee-O-nee[1]	[2]dhee-O-nee[1]	die-OWN-ee	dee-O[1]-nee
Rhea	[3]HRAY-uh	RAY-uh	REE-uh	RAY-uh
Iapetus	YA-peh-tos[1]	YA-peh-tos[1]	eye-AA-puh-tus	YA-peh-tus
Hyperion	[3]hoo-PEHR-ee-on[1]	ee-PEHR-ee-on[1]	hy-PEER-ee-un	hy-PEHR-ee-un
Phoebe	[4]FOI-bee	FEE-[4]vee	FEE-bee	FEE-bee
Titan	tee-TAN[5]	tee-TAN[5]	TIE-tun	TEE-tun

[1] "o" as in *for* or (French) *bon*

[2] "dh" as in *this, there*; hard "th" sound

[3] In ancient Greek, words beginning with vowels had breath marks, telling whether they were aspirated or unaspirated (spoken with or without an "h" at the beginning). The letter upsilon (in ancient Greek, pronounced like German "ü"; now, as "ee") always took the aspirated mark — thus the "hoo-" in Hyperion. Modern-day prefixes such as "hyper-," "hypo-," "hypno-," and "hypho-" are derived from this practice.

[4] The diphthong *οι* was pronounced "oy" in ancient, then evolved into "ee" in modern Greek. The letter *β* was pronounced "b" in ancient, then changed to "v" in modern Greek.

[5] This one threw me a curve. Greeks don't say "TEE-tan" — they never did. They say "tee-TAN," though.

A few by-the-ways: In the word *φοιβη*, the *η* was NEVER pronounced "uh"! The Greeks wouldn't have known a schwa (ə) sound if it hit them in their faces!

Also...Mr. Sterrenburg, you're not doing your homework. There *was* a Tethys, and she was a *Titaness*; she bore the rivers and three thousand Oceanides. Did you think that Cassini had no knowledge of Greek mythology when he discovered and named Tethys?

And...I agree that the name Saturn is an abomination — so are Mercury, Venus, Earth, Mars, Jupiter, Uranus, Neptune, Pluto, Juno, Pallas, Vesta, Ceres, and any other planets with Roman names. If I had my way I'd rename them all with Greek names. Unfortunately for us Greeks, the Romans had a lasting impact on our mythology.

To conclude, in considering the pronunciation of moons, never say, "This is the ONLY way..." There are many ways; just take your choice.

Stephen G. Volan
Merrillville, IN

Airstrip Threatens Kitt Peak

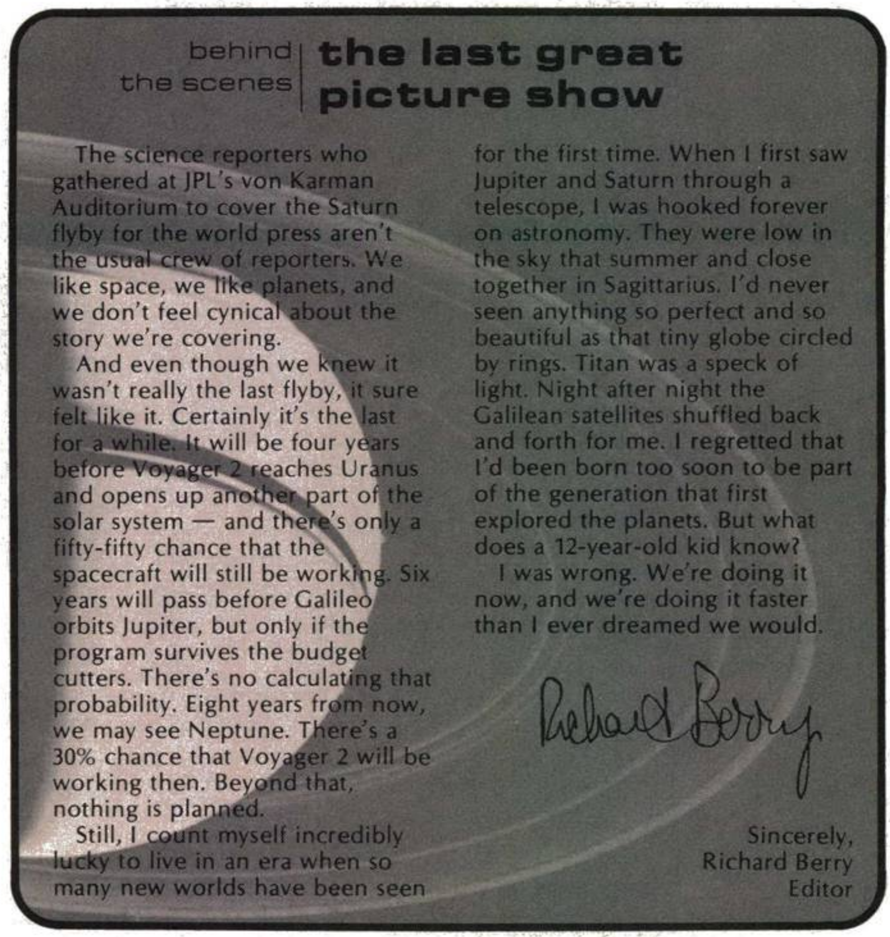
Richard Hill, resident observer at Kitt Peak's Warner and Swasey Observatory, has informed ASTRONOMY that the U.S. Air Force and the Air National Guard plan to build an airstrip near the Kitt Peak National Observatory. Light pollution from such an airstrip and its associated population increase would hamper the seeing in the area and severely diminish the scientific value of the observatory. Kitt Peak officials ask that you write each of the following politicians a letter urging them to find a new site for the airstrip — farther away from the National Observatory.

Governor Bruce Babbit
17 West Washington
Phoenix, Arizona 85007

Senator Dennis De Concini
4101 Dirksen Senate Office Bldg.
Washington, DC 20510

Senator Barry Goldwater
337 Russell Senate Office Bldg.
Washington, DC 20510

Rep. Morris Udall
1424 House Office Bldg.
Washington, DC 20515



behind the scenes | the last great picture show

The science reporters who gathered at JPL's von Karman Auditorium to cover the Saturn flyby for the world press aren't the usual crew of reporters. We like space, we like planets, and we don't feel cynical about the story we're covering.

And even though we knew it wasn't really the last flyby, it sure felt like it. Certainly it's the last for a while. It will be four years before Voyager 2 reaches Uranus and opens up another part of the solar system — and there's only a fifty-fifty chance that the spacecraft will still be working. Six years will pass before Galileo orbits Jupiter, but only if the program survives the budget cutters. There's no calculating that probability. Eight years from now, we may see Neptune. There's a 30% chance that Voyager 2 will be working then. Beyond that, nothing is planned.

Still, I count myself incredibly lucky to live in an era when so many new worlds have been seen for the first time. When I first saw Jupiter and Saturn through a telescope, I was hooked forever on astronomy. They were low in the sky that summer and close together in Sagittarius. I'd never seen anything so perfect and so beautiful as that tiny globe circled by rings. Titan was a speck of light. Night after night the Galilean satellites shuffled back and forth for me. I regretted that I'd been born too soon to be part of the generation that first explored the planets. But what does a 12-year-old kid know?

I was wrong. We're doing it now, and we're doing it faster than I ever dreamed we would.

Richard Berry

Sincerely,
Richard Berry
Editor

Our free discount price list will save you money!

Now in our 3rd year!

Before you buy *any* telescope or accessory, send for our *free* discount price list showing more than 70 telescopes and 500 accessories from **Celestron, Meade, Unitron, Questar, Edmund, Tele-Vue, Olympus Cameras, Vivitar, Quantum, Brandon, University Optics, DayStar,** *and others* — or send $1 (refunded with first order) for information-packed catalogs, sheets on how to pick the right telescope and accessories, *and more!* We've become one of the top ten Celestron dealers in less than two years. Our discount price list will show you why!

Ad•Libs Astronomics
2140 Melrose Court, Norman OK 73069
(405) 364-0858
© 1981 by Ad•Libs Advertising, inc.

Keep Up With the Exciting New Developments in Astronomy...

ASTRONOMY
A Self-Teaching Guide, 2nd Ed.
Dinah L. Moché
304 pp. $7.95 paperback

Explore the universe of stars, galaxies, and possible life beyond earth with this popular self-instructional guide. This new edition brings you up-to-the-minute on exciting discoveries from the Viking, Voyager, Pioneer, Landsat, and Solar Maximum missions, with spectacular new photographs and fascinating scientific insights.

Praise for the first edition—
"A lively up-to-date account of the basic principles of astronomy and exciting current fields of research." *—Science Digest*

"Equally useful to both the layperson and the experienced amateur astronomer." *—The Strolling Astronomer*

Available at your favorite bookstore.

JOHN WILEY & SONS, Inc.
605 Third Avenue, New York, N.Y. 10158
In Canada: 22 Worcester Road, Rexdale, Ontario M9W 1L1

2-1416

Dazzling New Astronomy Map Glows In The Dark And Shows All Four Seasons At Once

Introducing **The Astronomy Map.** After three years of development by some of America's leading astronomers, this is the star map against which all others will be judged.

The Astronomy Map shows more than 3,000 stars and all 88 constellations. These are printed in a luminescent ink on a dark blue celestial field. It glows in the dark after exposure to light.

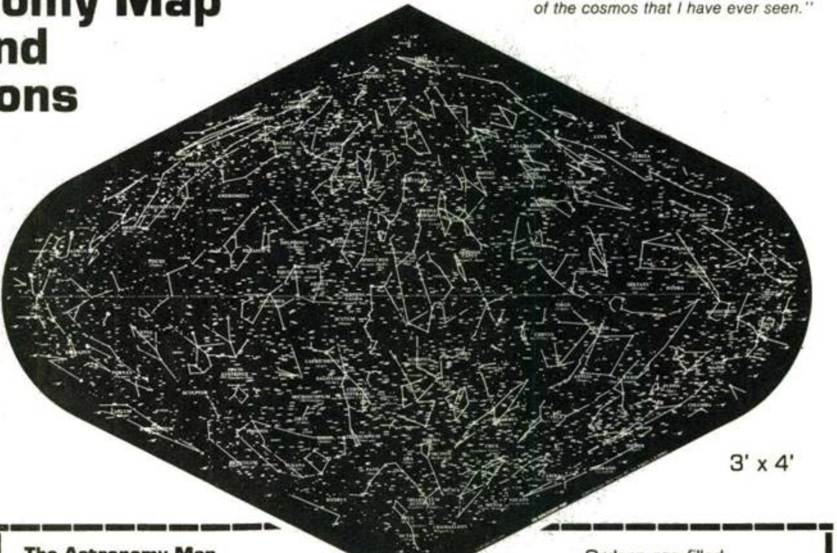
The Astronomy Map shows how the stars appear at any time during the year, from any place on earth. It is a complete reference piece for the astronomy enthusiast, and a stunning work of art for the home.

The Astronomy Map is in the shape of a huge diamond, measuring four feet wide by three feet high. This unique shape is the result of using a sinusoidal computer projection of the northern and southern hemisphere skies onto one flat plane.

This projection method allows us to depict the placement of stars from the point of view of both hemispheres with minimum distortion.

The stars vary in size according to their visual magnitudes. The shapes of all 88 constellations are highlighted by glowing connector lines, and named in both English and Latin for ready identification.

"....the most authentic year-round projection of the cosmos that I have ever seen."



3' x 4'

The Astronomy Map.
For yourself, or as a gift.
Only **$12.95,** plus **$2.00** for postage and handling.

Absolutely no risk! If not entirely delighted, return your Astronomy Map within 30 days for a full refund. Order now! (COD's send $3.00 with order, pay balance on delivery.)

Send check or money order along with this coupon to:

ASTRO SCENES
11340 Olympic Blvd., Suite 381
Los Angeles, CA 90064

Orders are filled within 48 hours from receipt.

CR. CARD CUSTOMERS, CALL TOLL-FREE ANYTIME
800-528-6050, Extension 1497
(California residents please add 6% sales tax)
VISA, Master Card, American Express accepted.

Signature ____________
Name ____________
Address ____________
City ________ State ________ Zip ________
Credit Card Type ____________
No. & Exp. Date ____________ AM 1

Low-Tech Telescope

Making a telescope complicated doesn't always make it better.

8″ f/6

$379

F.O.B. Santa Cruz, CA
plus $19 packing charge

When John Dobson started knocking together telescopes in San Francisco garages and basements over a decade ago, he wasn't trying to build a better telescope. He just couldn't afford anything that wasn't simple and cheap. By thinking "simple" he managed to design the most stable, low-cost telescope mount ever built. His compelling desire to share his love of the heavens with others led to hundreds (if not thousands) of amateur telescope makers' imitating his "Dobsonian" mount—because it was the best design ever conceived for low-cost, high-performance use. It didn't just work—it worked better.

WORKING WITH GRAVITY

The Dobsonian mount has one overwhelming advantage over other designs—it doesn't try to fight the laws of gravity. Its center of gravity is directly over the centers of rotation in both axes, so no matter where the telescope is pointed, weight is evenly distributed through the mount to the ground. This unique capability results in a **dramatic reduction** in vibration and oscillation, the inevitable downfall of many telescope mounts. In many telescopes, the image seems to "dance" around forever after the scope has been touched for focusing or adjustment.

Almost all conventional telescopes use bearings which are very low friction—so low, in fact, that without **adding** friction with a separate brake or clamp, the telescope would swing wildly at the slightest touch or hint of wind. The Dobsonian's unique design uses bearing materials that result in just the right amount of friction, working again with gravity. The characteristic "buttery" feel of the Dobsonian mount makes scanning through the sky truly effortless.

WE CHANGED IT

The typical home-built Dobsonian uses a heavy plywood box resting on a thick square plywood "ground-board" — the weak link in the system. It must be very heavy to avoid flexure, and has little ground clearance. We didn't like the ground-board. After considerable experimentation, we invented our exclusive Omnitorial™ mount (Patent Pending), which combines a strong, light-weight plywood tripod with a plastic-and-plywood cylindrical base. The result is a compact, attractive, high-performance mount unmatched by any conventional design. The low cost of the mount lets us put a bigger share of the telescope's cost where it counts—the optics.

OPTICS NOTHING NEW

There's nothing revolutionary about our optical system. Sir Isaac Newton invented it back in 1668, and it's the same system used in the 200-inch Hale telescope at Mount Palomar. More amateur astronomers use Newtonian reflectors today than any other kind. The resolution, contrast, and efficiency of the Newtonian system is not exceeded by any other reflector design. Our primary mirror is full-thickness Pyrex, precisely ground and polished to meet theoretical limits of performance, aluminized and Silicon monoxide overcoated. The eight-inch aperture mirror has 77% greater light-gathering power than six-inch reflectors—a significant improvement.

NO SATISFACTION

Gadget buffs will get no satisfaction from our telescope. There are no fancy precision metal parts to please the machinist; no drive motors or flashing lights for the electronics buff; no camera adapters, guide scopes, or off-axis guiders for the photographer. The delightful aspect to this seeming lack of features is simple: it doesn't need any of these things. This is a telescope designed for one thing and one thing only: **viewing the heavens.** Beginning and advanced amateur astronomers alike will be taken in by the simplicity of operation and the corresponding freedom from time-consuming polar alignment, drive adjustment, balancing, and involved set-up. Sets up in only a minute or two, without tools. (At star parties, you'll be the first one viewing!)

COMPLETE AND READY TO USE

• 8-inch, f/6 optical system • 1¼″ rack-and-pinion focuser • 6 x 30 achromatic finder scope • 2 fully-coated eyepieces • Built-in eyepiece/accessory case • 4-vane secondary mirror support system with full-sized elliptical diagonal mirror • Sturdy Tri-Axial™ tripod and Omnitorial™ mounting system (Patent Pending) • Huge anti-backlash Dobsonian bearings.

If you've been waiting until you could afford a more expensive telescope, wait no longer. I urge you to order our new telescope today. Try it out during our 90-day trial period. You'll be amazed at its performance. But, if it's not exactly what you want, just return the unit during the 90-day trial period for a full, immediate refund, including the $19.00 packing charge.

To order, send your check or money order for $379 plus $19 packing and handling to Orion. For a free descriptive brochure, call or write. We expect demand to be heavy, so order now for earliest delivery. We'll ship your telescope, complete instructions, and our exclusive two-year limited warranty. Order yours today!

ORION
TELESCOPES

P.O. Box 1158-A (408) 476-8715
Santa Cruz, Calif. 95061

eye
on the
sky

planets return as nights grow longer

by
Fred Schaaf

the wanderers

The only planet visible in the evening sky now is **Venus**, which will brighten rapidly from about -3.9 to -4.3 in November. During the next few months, the Evening Star will be an exciting object to follow through swift changes, as it first gains altitude and then takes a breathtaking dive out of the evening heavens.

Venus reaches greatest elongation, its largest angular separation from the Sun, on the evening of November 10, but for northern hemisphere observers it is still not very high at sunset because it lies in the far southern part of the zodiac. Our "sister planet" continues to gain altitude each night for North American viewers, reaching its peak above the western horizon more than a month after greatest elongation — an unusually long time. At 40° N. latitude, Venus sets 2.5 hours after the Sun on November 1 and almost 3 hours at month's end.

Although for mid-northern latitudes this isn't a very favorable apparition of Venus, it is excellent for southern hemisphere observers. The angular separation of Venus from the Sun can only vary by a few degrees from one greatest elongation to the next, because Venus' orbit is nearly circular. For this elongation we will have the slight advantage of Venus being particularly far from the Sun, since it was at aphelion on October 7. This month's greatest elongation of 47.18° will be the largest angle of separation until 2033.

Venus passes directly in front of the 2.1 magnitude star Sigma (σ) Sagittarii (Nunki) on November 17, but this rare occultation will occur when Venus is still below the eastern horizon for North American observers. However, watch the very close conjunction later that night. Using Venus as a guide, how soon after sunset can you detect Nunki? On the evening of the 27th, Venus is within 9' of 4.7 magnitude 52 Sagittarii — you'll need binoculars.

Although brilliant Venus attracts much attention this month, the pre-dawn sky is rich with planets for early risers. **Mars** is high in the southeast in Leo as morning twilight grows and the ruddy planet is brightening appreciably. It was faintest (+1.8) in late August and still only +1.7 when it passed Regulus late last month, but by the end of November it will rival Regulus. On the 22nd and 23rd, Mars is very close to 4.1 magnitude Sigma (σ) Leonis.

Far more beautiful are the configurations of the three planets climbing higher into the pre-dawn heavens. The faintest and highest of the three is **Saturn**, rising about two hours before sunrise at month's start and more than four hours before at month's end. Saturn should not be confused with the similarly bright, +1.0 magnitude star Spica, which is lower and just a few degrees to the right of the brightest planet here, **Jupiter**. This gas giant shines at -1.2 early in the month but is nearly rivaled by the passage of Mercury.

Mercury is at a greatest elongation of only 18.8° from the Sun on November 3 and is favorably placed about 5° north of Spica. For the entire first week of November, Mercury escapes completely from astronomical twilight — allowing North American observers their only glimpse of the planet in a dark sky this year.

Mercury's second conjunction with Jupiter will be a treat for United States observers on the mornings of the 5th and 6th. At that time Mercury will be about -0.5 and 2° from Jupiter.

The **Moon** sweeps by Mars, Saturn and Jupiter on the 20th, 22nd and 23rd, but by this time Mercury will have dropped far down into the solar glare.

Venus is already near maximum brightness at month's end. On the 30th, an hour or two before sunset (a little earlier on the Pacific coast), the Moon will be about 3° north of Venus. This will be a good time to try a naked-eye sighting of the planet in the daytime. Later, you can enjoy the beauty of the two together in the shades of evening.

the starry sky

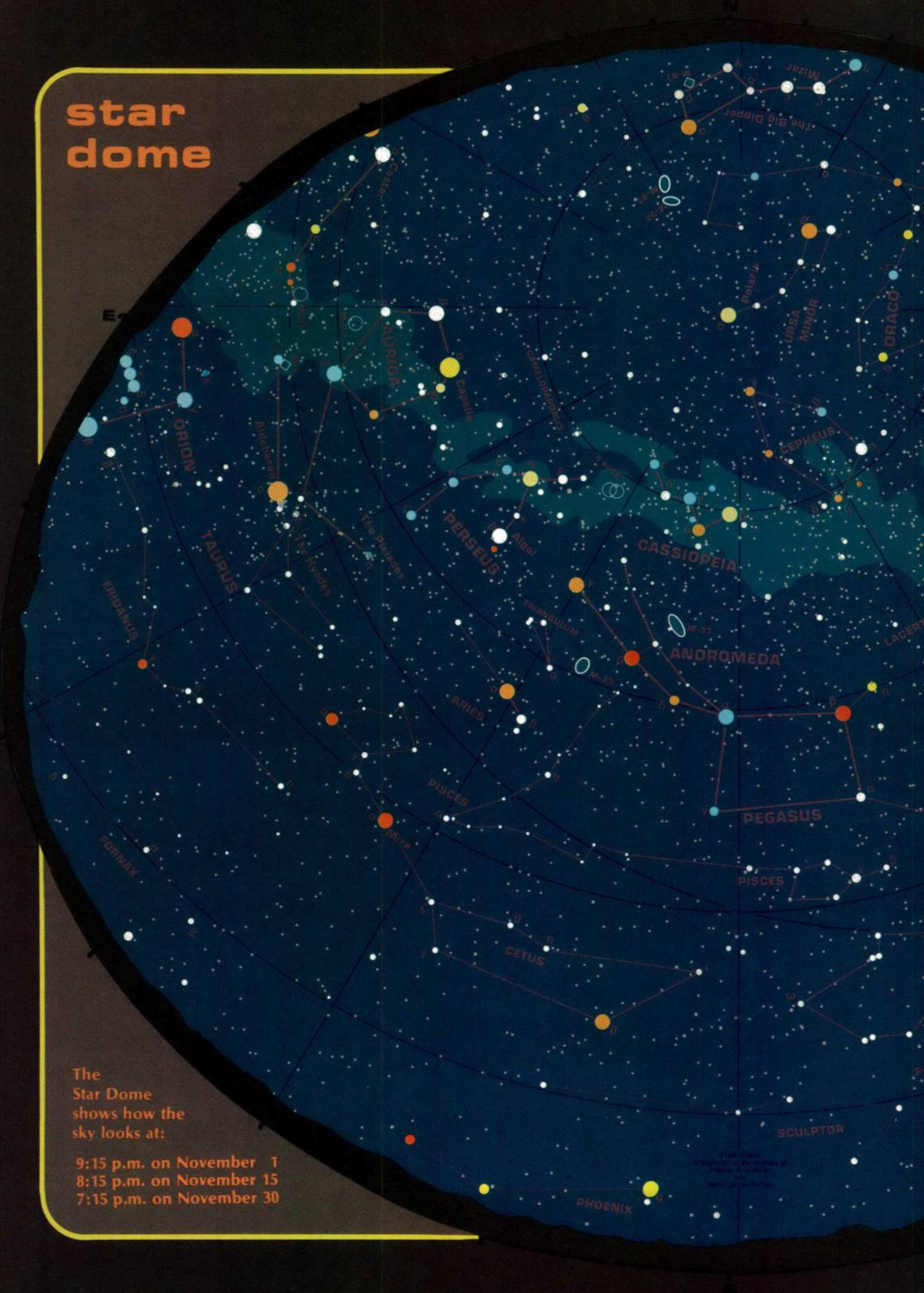
Last month we studied the constellations of the Water, or Celestial Sea. One of the central members was left unmentioned, because it was still ascending and is better seen in November-December. That figure also belongs to another collection of constellations, all linked by a single great myth. These shine high overhead or in the north — the places we will fix our attention this month.

High in the north is a circumpolar star pattern seen from the United States and Canada. The prominent "M" of **Cassiopeia** the Queen is as good a guide to the North Star in autumn as the Big Dipper is in spring. During November the **Big Dipper** is at its lowest, right on the northern horizon, for early evening viewers. Meanwhile, Cassiopeia's bright zigzag is far up above the North Star.

The most interesting of its bright stars is **Gamma (γ) Cassiopeiae**, also named Navi, though the star is sometimes known by its Chinese name, Tsih. Navi was a steady 2.25 magnitude object until 1910, when it began a peculiar variation eventually bringing its brightness to 1.6 in 1937. It was then the brightest north circumpolar star and second brightest

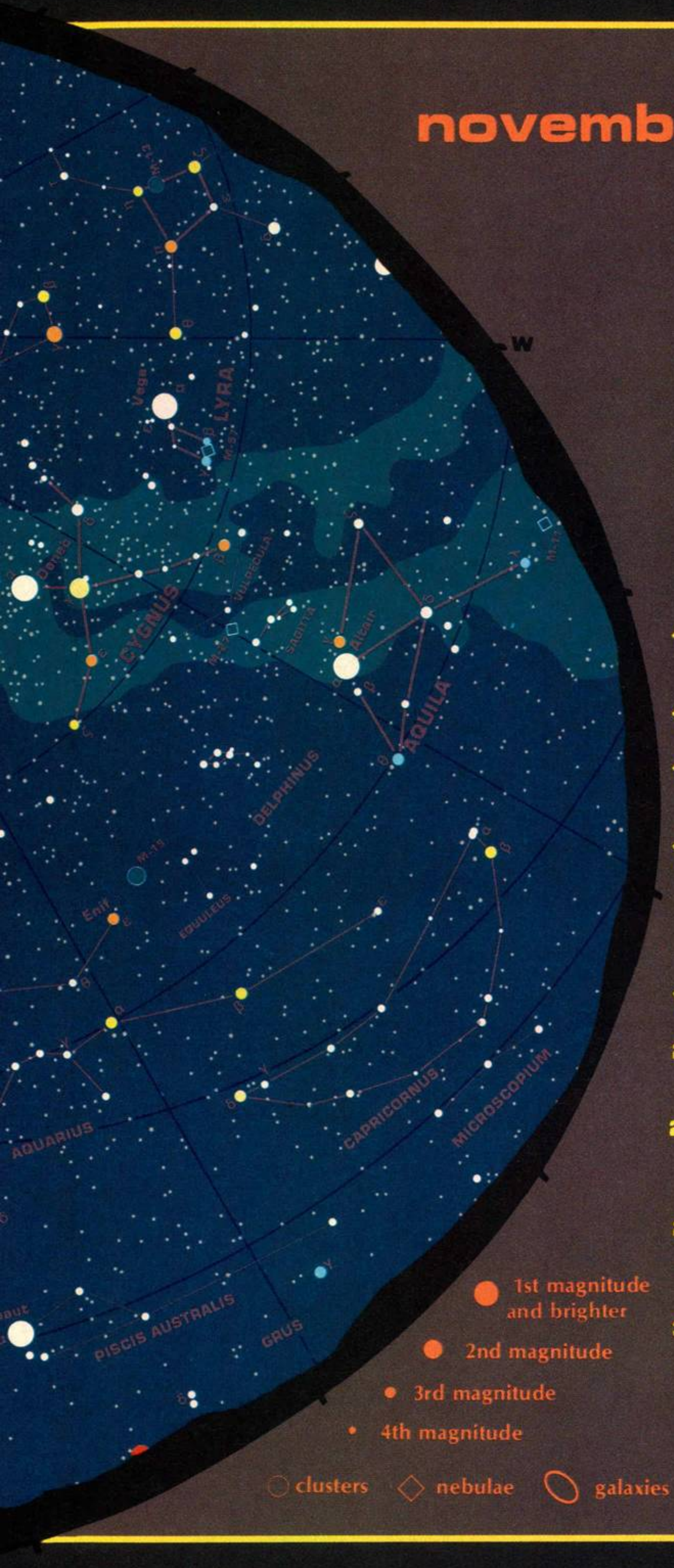
Conjunctions of heavenly bodies make great photographic targets — all you need are fast films and short exposures. David Pent of Phoenix, Arizona, included desert cacti to act as a frame for this 8-second exposure taken at f/2.8 with a 50mm lens. Adding foreground objects to conjunction photos enhances their visual appeal.

star dome


N
E
Mizar
M-97
The Big Dipper
M-81
M-82
Polaris
URSA MINOR
DRACO
Castor
AURIGA
Capella
CAMELOPARDALIS
CEPHEUS
ORION
Aldebaran
TAURUS
The Hyades
The Pleiades
PERSEUS
Algol
CASSIOPEIA
ERIDANUS
TRIANGULUM
M-31
ANDROMEDA
M-33
LACERT
ARIES
PISCES
PEGASUS
Mira
PISCES
FORNAX
CETUS
SCULPTOR
PHOENIX

The Star Dome shows how the sky looks at:

9:15 p.m. on November 1
8:15 p.m. on November 15
7:15 p.m. on November 30


W
M-13
Vega
LYRA
M-57
Deneb
CYGNUS
VULPECULA
M-27
SAGITTA
Altair
AQUILA
M-11
DELPHINUS
M-15
Enif
EQUULEUS
AQUARIUS
CAPRICORNUS
MICROSCOPIUM
PISCIS AUSTRALIS
GRUS
1st magnitude and brighter
2nd magnitude
3rd magnitude
4th magnitude
clusters
nebulae
galaxies

november sky almanac

1st	From the 1st of November until about the 21st, you can see Mercury low in the eastern sky in the hour before sunrise. (Jupiter and Saturn are there, too.)
3rd	The Taurid meteor shower will be at its peak this morning producing 5 to 15 meteors per hour.
4th	The Moon is at First Quarter at 8:09 p.m. EST.
6th	Mercury and Jupiter will be close together in the morning sky. Look to the east in the hour before sunrise.
10th	Venus will be at greatest eastern elongation from the Sun tonight.
11th	Full Moon is at 5:26 p.m. EST.
12th	The Moon is at perigee (closest to Earth) this morning: 221,895 miles.
17th	The Leonid meteor shower peaks early today. Spectacular at intervals of 33 years (the next is due in 1999), the display this year will be hampered by bright moonlight.
18th	Last Quarter Moon is at 9:54 a.m. EST.
20th	In the predawn sky, the crescent Moon will lie near Mars in the constellation Leo.
22nd	The Moon will lie near Saturn early this morning. You'll get the best view about 45 minutes before sunrise.
26th	The Moon will be New at 9:38 a.m. EST. Seven hours later, it's at apogee (farthest from Earth): 252,672 miles.
30th	Tonight, the Moon will lie to the lower right of Venus in the western sky. Make sure you have a clear view to the southwest.

Auriga, the charioteer, rises brightly at about 9 p.m. during November and is easy to locate. Its main shape is a pentagon, and its brightest star, Capella, is located at bottom right. Auriga also contains many interesting deep-sky objects. Jeffrey B. Prince of North Hampton, Massachusetts, submitted this unguided shot.

of the traditional autumn stars. By 1940 it faded to 3rd magnitude, but it has brightened again to 2.2; the star obviously warrants close attention. How bright do you rate it tonight?

In mid-November, the husband of Cassiopeia, **Cepheus** the king, is descending in the northwest, but the Queen's daughter, **Andromeda**, is directly overhead (as seen from between 30° and 50° N. latitude) at 8 to 9 p.m. local time. The Chained Maiden is composed of two strands of stars, one bright and one faint, diverging northeast from the star Alpheratz. **Alpheratz** (also known as Sirrah) is the northeast and brightest member of the **Great Square of Pegasus**, which rides high in the south — but Alpheratz officially belongs to Andromeda, not Pegasus. The bright line from Alpheratz is composed of **Mirach** and **Almach**, stars equal in magnitude to Alpheratz. Almach is a fine yellow and blue double star at low powers in telescopes.

Just off the fainter strand of stars in this constellation is a most interesting object: M-31, the great **Andromeda Galaxy**. This mighty spiral star-wheel, the largest member of our Local Group, is 180,000 light-years across and contains several hundred billion stars. M-31 is so luminous that it is visible to the naked eye in dark skies even though it is located 2.2 million light-years from us. Its total apparent magnitude is 4.6, but its apparent size to the naked eye is what is notable. Whereas most telescopes reveal only a degree (or less) of the bright central regions, the unaided eye or good binoculars can often show this patch elongated to several degrees — or in the most extreme cases, as much as 4° to 5°. How far can you trace its length on various nights?

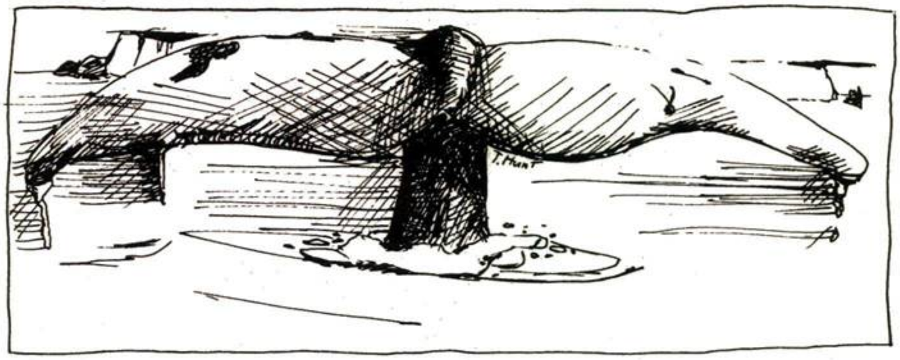
The two strands of Andromeda extend east toward the constellation of the hero who saved her in Greek mythology. He is **Perseus** and his constellation is not only bright and striking, but also filled with special objects of interest to naked-eye and binocular observers. The classic and brightest example of an eclipsing binary star system is **Algol**, the point of light second brightest in Perseus, but which at intervals of 2.86739 days rapidly fades from 2.3 to 3.4 (there is also a very slight fading when the faint star is partly eclipsed by the brighter). Be sure you do not use **Rho** (ρ) **Persei** (the fairly bright star near Algol) as a comparison — it is also a variable, ranging semi-regularly from about 3.3 to 4.0.

During November take time to look at the awesome **Double Cluster** of Perseus, located between his main stars and those of Cassiopeia. This pair of objects is visible to the naked eye — as a dim hazy spot — even in many urban areas on good nights.

The long leg of Perseus, which extends to the south, points to the loveliest of all clusters, the **Pleiades**. Nearly everyone has seen this group at one time or another, and its ascension in the east heralds the appearance of the rest of **Taurus** the bull and the bright star **Aldebaran** (whose name means "the follower" — probably because it follows the Pleiades). Farther to the north, rising below Perseus, is the brighter star **Capella** in **Auriga** (the charioteer). But these are actually winter constellations and there are interesting autumn constellations much higher in the sky.

South of Andromeda shines the small **Triangulum** the triangle and **Aries** the ram. Aries contains one of the brightest stars of autumn, second magnitude **Hamal**, which has a slightly orange hue. These two constellations and dim **Pisces** the fish separate the contiguous area of Cepheus, Cassiopeia, Andromeda and Perseus from the final great character in the myth that is represented as a constellation — **Cetus** the whale.

In the original myth the monster was of unspecified type, and the pattern of the stars here is more suggestive of a plesiosaur than a whale! The two brightest stars here — normally — are **Menkar**, in the prominent head, and **Diphda**, in the tail (another name for this star is Deneb Kaitos, which means "the tail of the whale"). In the long neck of Cetus is a variable star as famous as Algol. Its name is **Mira**, which means "wonderful" and it is the brightest of the long-period variables. Mira ranges from roughly 9th to 3rd magnitude in a period which averages 331 days. This year maximum was predicted for early August, so by early November this star is probably no longer visible to the naked eye. Just a few years ago Mira became a 2nd magnitude object, and once it even brightened almost to the same magnitude as Aldebaran (0.9).



Early November is still mid-autumn and there is a lot to see in the seasonal constellations. Before the brilliant cavalcade of winter stars rush in, get under dark skies and become a patient connoisseur of the dim southern constellation, the Water. Among all the central constellations of this group, there is only one star — besides the bright members of Cetus — which is brighter than 3rd magnitude. That star shines all by itself, already sinking in the southwest in the middle of November evenings. It is **Fomalhaut**, which Leslie Peltier justly named "the Autumn Star."

skylore

The Greek myth that has Perseus as its central figure is one of the greatest tales of mankind. That surprising, ghastly, and beautiful story deserves to be read in its full richness. Here I want to concentrate on the non-Greek legends and lore surrounding one of the constellations we name from the Perseus myth, the constellation of the Queen, Cassiopeia.

The pattern of Cassiopeia has been identified with the constellation of the Leg, mentioned in the Egyptian *Book of the Dead*. But the early Arabs named this area the "Hand Stained with Henna" (henna is a reddish dye used as a cosmetic and hair coloring). The five main stars of Cassiopeia were, however, only the fingertips of this large pattern; the wrist was formed by the Double Cluster of Perseus. The Early Arabs pictured Cassiopeia and Cepheus as two dogs, and Al Tizini pictured a kneeling camel from some of the stars of Cassiopeia. The people of Persia at that time also imagined our Cassiopeia to be a camel, calling it *Shuter*.

The constellation had a very honored place in the legends of the Celtic peoples. In Welsh legends it was Llys Don, the court of the great goddess Don. Among the children of Don were her daughter Arianrhod, whose heavenly home was Corona Borealis, and her clever son Gwydion, who made the Milky Way. The Irish counterpart of Don was Danu. Bright Cassiopeia has been known as many things in many cultures. In addition to being the Queen, ancient Greeks sometimes considered it a key. The early Chinese called just one small, faint part of our present constellation, Ko Taou, the porch-way, but the name of Wang Liang, a famous charioteer who lived about 470 B.C., was applied to the prominent Alpha, Beta, Eta and Kappa.

An Eskimo title for the triangle of Alpha, Beta and Gamma Cassiopeiae is Ibrosi, supposedly three rocks which support a celestial "stone lamp." Grimm thought that Cassiopeia was the Lithuanian Jostandis, from Josta, a girdle. And in the modern mythology of Tolkien's *The Silmarillion*, the elvish constellation Wilwarin — "butterfly" — is probably Cassiopeia.

This constellation was frequently mentioned by writers of classical antiquity and by many great writers since. Spenser mentions "the shinie Cassiopeia's chair." The poet Gerard Manley Hopkins was a marvelous observer of nature whose journal entry for July 9, 1868 was: "Before sunrise looking out of window saw a noble scape of stars — the Plough all golden falling, Cassiopeia on end with her bright quains pointing to the right, the graceful bends of Perseus underneath her, and some great star Capella or not I am not sure risen over the brow of the mountain." The word "quain" is a dialect form of "quoin," a wedge or corner, and Hopkins used it to describe pointed projections. In this case, the quains are the two points which are the tops of the "M" in the high Cassiopeia and the bottoms of the "W" in the low Cassiopeia.

Perhaps the most memorable mention of Cassiopeia in modern literature appears in Thoreau's *Walden*: "Where I lived was as far off as many a region viewed nightly by astronomers. We are wont to imagine rare and delectable places in some remote and more celestial corner of the system, behind the constellation of Cassiopeia's Chair, far from noise and disturbance. I discovered that my house actually had its site in such a withdrawn, but forever new and unprofaned, part of the universe."

Holiday Gifts from the

ASTRONOMY Bookshelf

Illustrated Encyclopedia of Space Technology

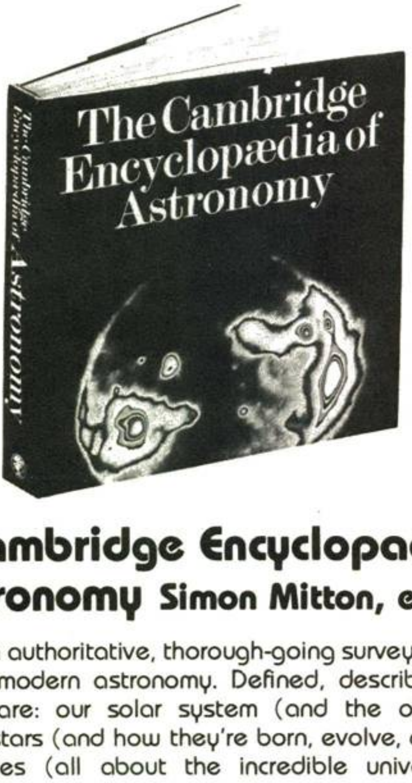
Kenneth Gatland, chief author and consultant

This is the book every space-buff has been waiting for! Full of color and crammed with facts about mankind's development of rockets and space vehicles. For instance, in it, you'll find cut-away diagrams of all the Apollo hardware: lunar rovers, spacesuits, the LM, the Command Module and lots more. Even Skylab and the Russian Salyut space station are presented in glorious detail. There's also a large fold-out chart that shows — to scale — every space-faring country's rocket launchers.

Coupled with the fantastic diagrams is a detailed and informative text with 21 chapters devoted to such subjects as "The Space Centers," "The Space Factory," "Military Space Systems," "Space Cities," "Probes to the Planets" and others.

For anyone fascinated by space, this is one book not to miss! 290 pages, large-format, hardcover, $26.50

SPACE TECHNOLOGY



The Cambridge Encyclopaedia of Astronomy

Simon Mitton, editor

This is an authoritative, thorough-going survey of every aspect of modern astronomy. Defined, described, and explained are: our solar system (and the objects it contains), stars (and how they're born, evolve, and die), and galaxies (all about the incredible universe we inhabit).

Completely indexed for quick, efficient reference, the **Encyclopaedia** was designed for more than just looking up isolated facts. Dip into it anywhere and you can pick up the on-going story. Illustrated with color photographs, charts, diagrams, and historical pictures, it's a must for your astro-library. 481 pages, hardcover, $41.50

TO ORDER, USE ASTROMEDIA FORM BOUND INTO THIS MAGAZINE

Burnham's Celestial Handbook: Burnham. The great modern classic about deep-sky objects; arranged by constellation, it covers the whole sky in 3 volumes. 2138 pages in all, paper, $9.50 per volume.

Celestial Objects for Common Telescopes: Webb. Volume 1 is about the solar system; volume 2 covers all else, constellation by constellation. 606 pages in all, paper, $10.00 (set).

Seasonal Star Charts. Guide to the heavens with 8 star maps and accompanying lists of objects in each constellation; has Star Finder planisphere on cover. 23 pages, plasticized paper, ring-bound to lie flat. $9.25.

The Milky Way: Bok & Bok. The absorbing saga of galactic discovery — within our own "island universe." Tells how the shape and size of the Milky Way were dimly recognized and brought into clear focus. 273 pages, paper, $8.50.

Earthlike Planets: Murray, Malin & Greeley. The solar system from Mars inward viewed as complete worlds with unique landforms and geological histories. 387 pages, paperback, $15.50.

Astronomy with Binoculars: Muirden. The classic guide, newly updated, to skywatching with the simplest equipment. Includes how to buy a good pair of binoculars and observing projects. 156 pages, hardcover, $10.50

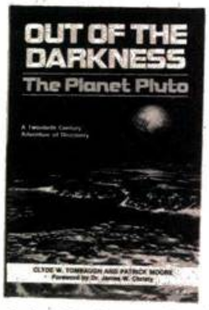
Concise Book of Astronomy: Mitton & Mitton. Intended for any newcomer to the subject, this book is simply written and colorfully illustrated. 96 pages, hardcover, $13.50.

New Concise Atlas of the Universe: Moore. Large, "coffee-table" guide to the sky with almost 1000 photos, 400 in full color. 190 pages, hardcover, $35.00.

Star Finder. Excellent observing aid. Shows what's up at any time during the year: find out when Betelgeuse sets or Cetus rises. Paper, $5.95.

Sky Scanner: Nowell. Handy-sized star charts with only the brightest constellations; ideal for learning the sky. 12 pages, heavy paper, lies flat, $4.95.

Amateur Astronomer's Handbook: Sidgwick. Tips on mountings and drives, eyepieces, mirror and lens testing — as well as data on human vision, the Earth's atmosphere, etc. 572 pages, paperback, $7.50.

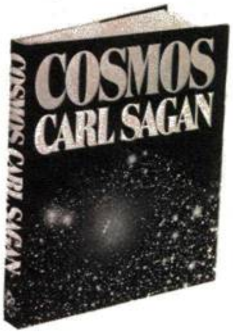


Out of the Darkness: the Planet Pluto: Tombaugh & Moore. The absorbing story of how the 9th planet in the Sun's family was found — told by its discoverer! 221 pages, hardcover, $15.50.

The Messier Album: Mallas & Kreimer. An observer's guidebook to the whole Messier catalog — a finder chart, visual sketch and description, and a photo on each. 248 pages, hardcover, $14.50.

Observational Astronomy for Amateurs: Sidgwick. A collection of facts on observing techniques covering the Sun, Moon and all the planets, as well as aurorae, meteors, zodical light and double stars. 358 pages, paperback, $5.00.

Astronomy Facts & Feats: Moore. The "Guinness Book of Astronomy." Perfect book for settling arguments — or showing off your command of arcane astronomical knowledge. Good reference value, too. 288 pages, hardcover, $18.50.



November Special: Cosmos Price: $18.95

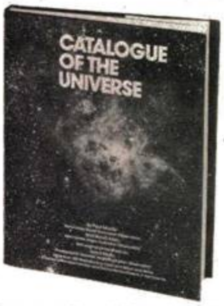
Cosmos: Sagan. A lucid, colorful and exciting print version of Carl Sagan's acclaimed public television series. 365 pages, hardcover, $18.95 **Order by November 30!** (regular price: $20.50)

The Radiant Universe: Marten & Chesterman. Spectacularly colorful computer-enhanced space photographs have revealed the "old" universe in new and informative ways. 128 pages, hardcover, $18.50.

Monsters in the Sky: Maffei. All about BL Lacertae stars, black holes, quasars, to name just a few. A tour of astronomical oddities from comets to the most distant clusters of galaxies. 342 pages, hardcover, $15.50.

Astronomy: the cosmic journey: Hartmann. Profusely illustrated survey of astronomy without mathematics. Fully indexed with glossary. 536 pages, hardcover, $25.00.

The Amateur Astronomer: Rukl. A compendium of useful knowledge for any observer, this book also tells you where to look to find the naked-eye planets from 1979 to 2000. Eclipses and lunar phases, too! 184 pages, hardcover, $10.50.



Catalogue of the Universe: Murdin & Allen. An encyclopedic, illustrated description of each type of known object in the universe — from asteroids to clusters of galaxies. 256 pages hardcover, $18.50.

The Red Limit: Ferris. Thrilling story of modern cosmology and its practitioners. 287 pages, hardcover, $10.50.

Moon, Mars, and Venus: Rukl & Klepesta. Pocket-sized lunar atlas in 76 plates; also has topographic and albedo maps of Mars, and a radar map of Venus. 255 pages, hardcover, $5.50.

Astronomical Companion: Ottewell. Large-format book that provides a wealth of background information on astronomy. 73 pages, paperback, $12.50.

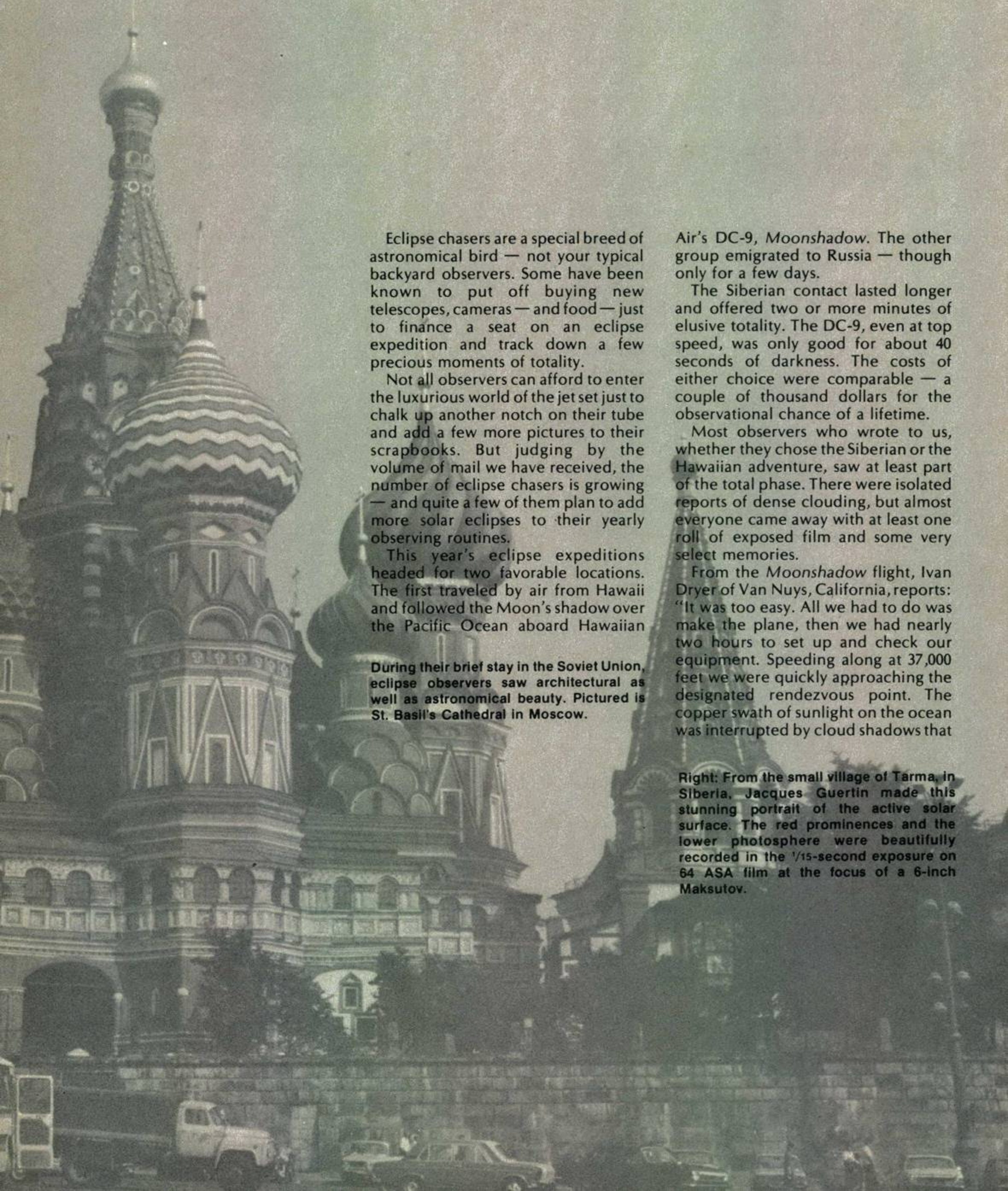
The Crab Nebula: Mitton. Tells all about what goes on in that gassy remnant of an exploded star. 194 pages, hardcover, $17.50.

ASTRONOMY: selected readings: Seeds. A gloriously colorful anthology of 11 of the best articles run in ASTRONOMY. Covers the whole range of astronomical research. 178 pages, paperback, $9.50.

The Big Bang: Silk. How the universe began and how it has evolved over the eons: the intriguing and at times bizarre story of cosmology. 394 pages, paperback, $9.50

gazer's
gazette

the july eclipse: a midsummer day's night



During their brief stay in the Soviet Union, eclipse observers saw architectural as well as astronomical beauty. Pictured is St. Basil's Cathedral in Moscow.

Eclipse chasers are a special breed of astronomical bird — not your typical backyard observers. Some have been known to put off buying new telescopes, cameras — and food — just to finance a seat on an eclipse expedition and track down a few precious moments of totality.

Not all observers can afford to enter the luxurious world of the jet set just to chalk up another notch on their tube and add a few more pictures to their scrapbooks. But judging by the volume of mail we have received, the number of eclipse chasers is growing — and quite a few of them plan to add more solar eclipses to their yearly observing routines.

This year's eclipse expeditions headed for two favorable locations. The first traveled by air from Hawaii and followed the Moon's shadow over the Pacific Ocean aboard Hawaiian Air's DC-9, *Moonshadow*. The other group emigrated to Russia — though only for a few days.

The Siberian contact lasted longer and offered two or more minutes of elusive totality. The DC-9, even at top speed, was only good for about 40 seconds of darkness. The costs of either choice were comparable — a couple of thousand dollars for the observational chance of a lifetime.

Most observers who wrote to us, whether they chose the Siberian or the Hawaiian adventure, saw at least part of the total phase. There were isolated reports of dense clouding, but almost everyone came away with at least one roll of exposed film and some very select memories.

From the *Moonshadow* flight, Ivan Dryer of Van Nuys, California, reports: "It was too easy. All we had to do was make the plane, then we had nearly two hours to set up and check our equipment. Speeding along at 37,000 feet we were quickly approaching the designated rendezvous point. The copper swath of sunlight on the ocean was interrupted by cloud shadows that

Right: From the small village of Tarma, in Siberia, Jacques Guertin made this stunning portrait of the active solar surface. The red prominences and the lower photosphere were beautifully recorded in the 1/15-second exposure on 64 ASA film at the focus of a 6-inch Maksutov.

Below: The partial phase, nearly half over, foreshadows the approach of totality. As the Moon covers up the last sliver of sunlight (top left, facing page), a double diamond ring forms — a rare occurrence captured with a 1000mm telephoto and a 1/1000-second exposure on Ektachrome 200. In Russia, light cloud cover dims this combined corona/diamond ring effect (top right), recorded through 450mm lens at f/8 on Ektachrome 200.

The corona of the July eclipse was one of the most active in recent years. A 1000mm Maksutov telephoto and a 1/4-second exposure (also on 200 ASA film) yielded this superb shot (bottom). As a fitting finale to the event, some observers were treated to a spectacular setting of the eclipsed Sun (background).

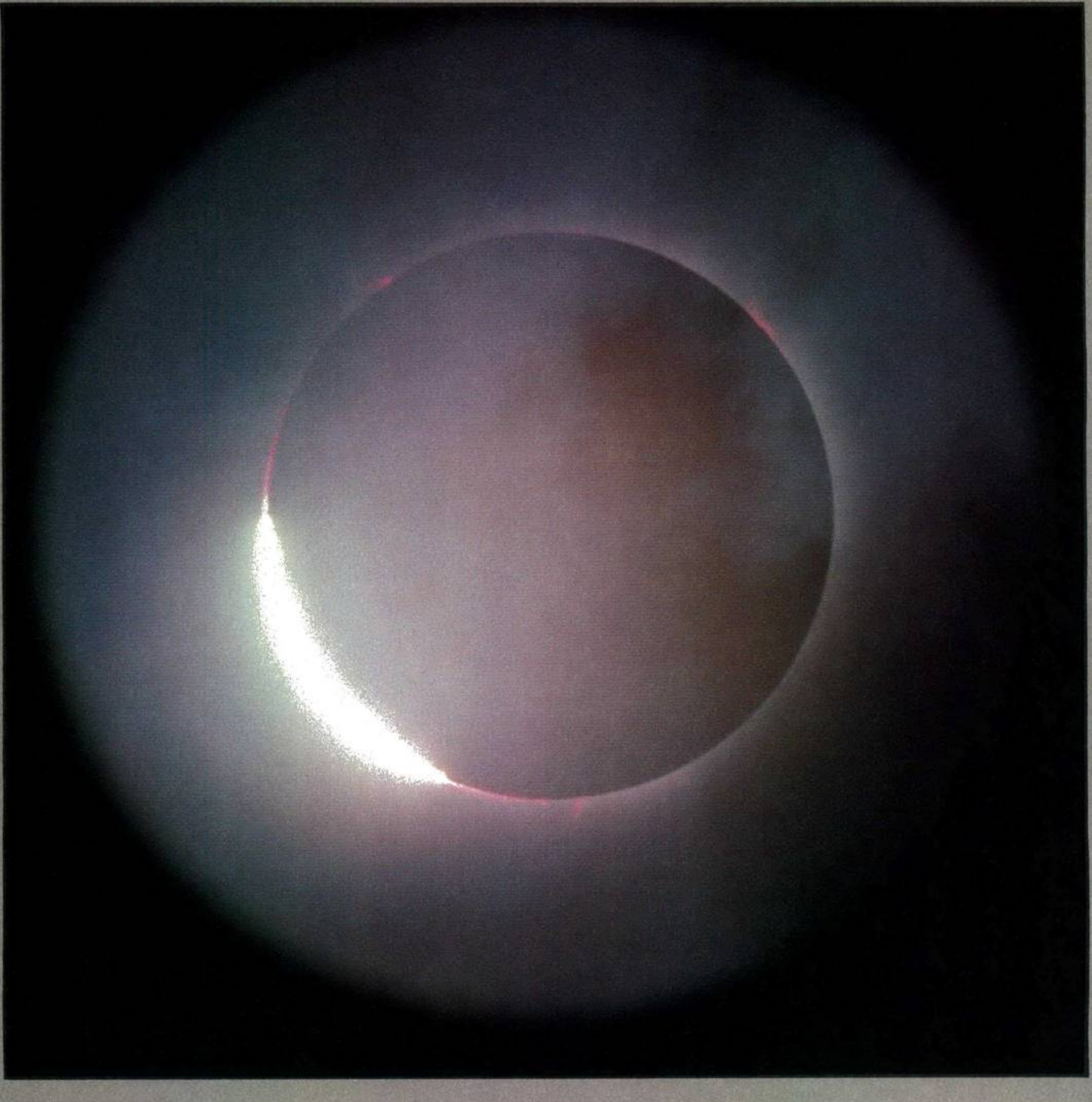
Jacques Guertin

R.M. Fingerhut

Jack Newton

Steve Greenburg

Don Trombino



Jacques Guertin used a 1-second exposure on Ektachrome 64 to shoot the corona through his 2900mm Maksutov.

grew paler in the waning light. Then we were there. Someone shouted 'Corona!' and there it was. A seemingly eternal diamond ring continued to flare at the point of second contact as clumps of prominences rimmed the advancing edge of the Moon. There wasn't time to do anything. In fact, I'd swear that as soon as the second contact diamond ring ended, the third ring began. In that split second I thought fondly and enviously of Siberia. Someone timed it as a little more than 30 seconds. We had missed our target by a few miles and that had cost us a few seconds of totality. Those in Siberia didn't get the sunset we had, though. An orange crescent slipped into a gold-edged thunderhead beneath a still-darkened sky that turned crimson and then slowly faded to grey."

Patty Winter, also on the *Moonshadow* flight, made this report: "In some ways every eclipse chaser's dream is to view an airborne eclipse, because you have no cloud worries, beautiful sunset colors all around the horizon, and a good view of the approaching Moon's shadow. However, airplanes vibrate, three layers of plexiglass separate your camera lens from the sky, and there's always the heart-stopping question: Will the chosen rendezvous point be correct?

"About 80 people boarded Hawaiian Air's brand new DC-9 for its maiden flight into the Moon's shadow. Shortly after take-off, as soon as the seat belt sign was turned off, a forest of tripods quickly sprouted on the right side of the plane in front of the 52 windows that were clear for observation. Since I had photographed last year's eclipse, I decided to sit this one out and just watch. I had no problem looking over the heads and shoulders of those jammed in front of the windows, but others weren't so lucky, finding themselves behind fidgety photographers and having to bob around to see the eclipse. The eclipse itself was brief but spectacular. To several of us, the corona appeared almost butterfly-shaped; others considered it more round. However, there was general agreement that it was not as uniform as in eclipses of the past two years. Third contact produced a double diamond ring as two parts of the photosphere emerged near each other simultaneously. No one complained, and at the end of totality, the crew popped open the champagne which flowed freely until we landed."

From Siberia comes a different story — one that almost ended in disappointment due to the vagaries of Soviet weather. Jacques Guertin writes: "The rains which had been constant throughout our stay in the Soviet Union stopped the day before the eclipse, and local meteorologists claimed that we had a 75% chance of clear skies the following day. The Russian authorities also told us that we would not be allowed to use the road to the government-chosen eclipse site because the local people might create problems by causing a traffic jam. We were therefore resigned to journey by boat to the site.

At 6:30 a.m. the next day we boarded the boat, prepared for the three-hour ride. As we proceeded, we watched with apprehension the build-up of clouds. Upon docking, we realized that we were not at the right observing area — the Soviets had changed the original site without informing us. This new situation was certainly not as favorable since we were flanked by a lake and a hill. From the boat it was at least a one kilometer walk to the observing area. The DC power promised to run clock drives was not provided until 20 minutes before totality. I could not believe what was happening, and the clouds seemed to be forming right in the vicinity of the partially eclipsed Sun. The partial phase was quickly coming to an end and the temperature dropped from 69°F to 63°F. The crowd of 600 eclipse enthusiasts started to get noisy. With about ten seconds left, only a tiny spot of sunlight remained. Then a beautiful diamond ring showed at second contact. The corona became visible. The diamond ring held on for five seconds. The last rays of sunlight pierced through a lunar valley. Totality. It was 12 noon local time.

The crowd went wild — cheering, yelling and using an assortment of expletives. I stopped shooting to check the alignment of the image; the view was simply incredible. I could easily see the lunar mountains in profile against the solar corona. I glanced away from the telescope looking directly at the eclipsed Sun, and then, with extreme reluctance, I returned to photography, getting off another couple of shots. Suddenly there was some light on the ground. I looked up. Third contact. I could not believe that the whole two minutes had gone by. The crowd applauded once more, and I heard voices already discussing plans for the next eclipse when the Moon's shadow touches the Earth again in another remote region."

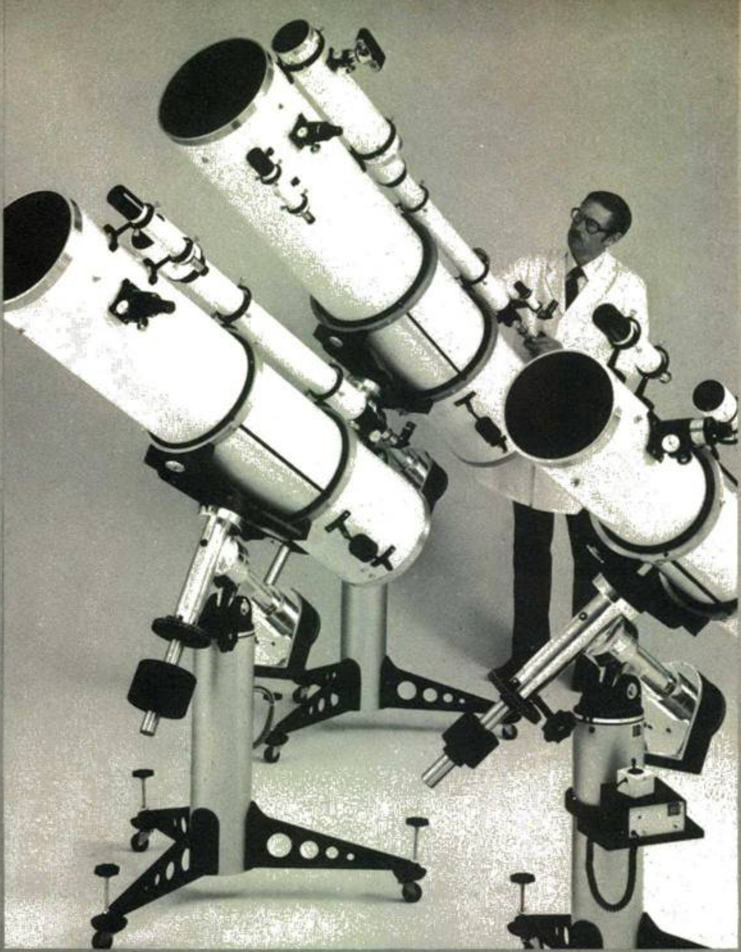
Eclipse preparations for the members of the *Moonshadow* expedition included setting up equipment in front of the DC-9's windows. Photo by Patty Winter.

Meade precision photo-visual reflecting telescope systems

Large-aperture, high-resolution optics from the world's largest manufacturer of reflecting telescopes for the serious amateur.

Meade 6″, 8″, 10″, and 12½″ reflectors achieve a new level of optical and mechanical excellence for the serious amateur. These totally integrated telescope systems include everything required for detailed study of the Solar System and Deep Space, and readily permit the observer to grow into more advanced subjects, such as long exposure astrophotography.

Designed by Meade engineers and in continuous production at our Costa Mesa facility, these telescopes possess capabilities generally obtainable only at much higher prices — and they are the only telescopes available which use exclusively the quality Meade components known throughout the astronomical world.



Meade Research Series (above) — The accepted standard of the American telescope industry for the advanced amateur.

COMPLETE RESEARCH SERIES REFLECTING TELESCOPES

Model 880: 8″ f/6 with Motor Drive	**$1295**
Model 1060: 10″ f/6 with Motor Drive	**1595**
Model 1266: 12½″ f/6 with Motor Drive	**1995**

Packing charges: 8″ — $50; 10″ — $60; 12½″ — $75. All prices F.O.B. Costa Mesa, Calif.

Model 826
8″ f/6
with Motor Drive
$549.95
Packing Charge: $25.00

Shown with optional Manual Declination and R.A. Controls, 2″ Photo-Guide Telescope, VariGuide R.A. Drive Corrector, Accessory Shelf.

COMPLETE REFLECTING TELESCOPES

All Meade reflecting telescopes now include high-transmission Multi-Coated eyepieces at no additional cost!

Model 628: 6″ f/8 with Motor Drive	**$439.95**
Model 618: 6″ f/8 without Motor Drive	**399.95**
Model 645: 6″ f/5 with Motor Drive	**449.95**
Model 635: 6″ f/5 without Motor Drive	**409.95**
Model 826: 8″ f/6 with Motor Drive	**549.95**
Model 816: 8″ f/6 without Motor Drive	**499.95**
Model 856: 8″ f/6 with Motor Drive, 2″ Photo-Guide Telescope, and VariGuide Dual-Axis Control System	**835.00**
Manual Declination control #55 for Models 628-856	**37.50**
Manual R.A. Override Control #57 for Models 628-856	**15.00**

Packing charges: 6″–$15; 8″–$25 – All Prices F.O.B. Costa Mesa, Calif.

COMPLETE EQUATORIAL MOUNTS. The same precision mounts used on Meade 600- and 800-Series reflecting telescopes. Each mount includes: ball bearing equatorial head, cradle rings, setting circles on both axes, pier, and tripod legs. Manual R.A. Override Control #57 is available for motor drive models.

Model 651: 6″ Equatorial Mount without Motor Drive	**$155.00**
Model 653: 6″ Equatorial Mount with Motor Drive	**215.00**
Model 851: 8″ Equatorial Mount without Motor Drive	**185.00**
Model 853: 8″ Equatorial Mount with Motor Drive	**245.00**
Manual Declination Control #55 for Models 651-853	**37.50**
Manual R.A. Override Control #57 for Models 653, 853	**15.00**

Packing charge on all mounts: $10 – All Prices F.O.B. Costa Mesa, Calif.

Meade

Research level telescope parts and accessories from America's No. 1 supplier to the serious amateur

RACK-AND-PINION FOCUSERS—Precision metal construction. All 3 models include helical-cut rack and variable-tension adjustment for ultra-smooth focusing without backlash. Universal bases fit all tube sizes. Standard 1¼" eyepiece holders. **Each focuser is guaranteed to be the finest obtainable in its class:**

1—MODEL 67—Strong, lightweight design for 4" to 10" telescopes. 2-3/16" travel. An excellent value. **$23.75 ppd.**

2—MODEL 640—A heavy-duty deluxe focuser for 6" to 16" telescopes. Full 3" travel for both visual and photographic applications. **$39.95 ppd.**

3—MODEL 680—Our finest focuser. Accepts both 1¼" and 2" eyepieces. Full 3" travel for photo or visual observing with 6" to 16" telescopes. **$49.95 ppd.**

4—NEBULAR FILTER—This revolutionary 3-channel filter effectively blocks sodium and mercury emissions from city lights as well as natural airglow, while transmitting 90% of critical visual nebular emissions. Dramatically improves telescope performance visually and photographically. Hermetically sealed, anti-reflection coated. 23mm clear aperture. Threads directly into all Meade 1¼" O.D. eyepieces. **$59.95 ppd.**

5—PHOTO-VISUAL COLOR FILTERS—Top quality optical glass, dyed-in-the-mass, with excellent spectral homogeneity. Mounted in machined metal cells which thread directly into all our 1¼" "Series 1", "Series 2", and "Research-Grade" eyepieces. Filters may be piggybacked. Listed by Wratten No. and color: **#8 Light Yellow—#11 Yellow-Green—#12 Yellow—#21 Orange—#23A Light Red—#25A Red—#47 Violet—#58 Green—#80A Blue—Polarizer (30% transmission).** Each filter: **$7.95 ppd.** Set of any 6: **$44.50 ppd.**—Full set of 10: **$73.50 ppd.**

6—VARIPAK DRIVE CORRECTOR—Model 43—A quality electronic guiding unit with supercompact (2" × 3" × 4") design. Fast-slow pushbuttons mounted on the power pack. Variable control for lunar, planetary, sidereal rates. Operates from 12 volts D.C., plugs into standard auto cigarette lighter. The 12-watt output is sufficient for most telescopes to 14" aperture. **$65.00 ppd.**

7—VARIGUIDE DRIVE CORRECTOR—Model 41—The finest R.A. drive corrector available. Includes aircraft-type joystick controller for continuously variable correction rates, not just "ON-OFF". May be used with any motor-drive-equipped telescope rated up to 12 watts, including most commercial telescopes to 14" aperture. Operates from 12 volts D.C. or 115 volts A.C./60Hz. Control box includes variable center-frequency settings for lunar, planetary, sidereal rates. **$119.95 ppd.**

8—6×30mm VIEWFINDER—Fine wide-field finder, the same unit supplied as standard equipment on Meade 6" and 8" reflecting telescopes. Actual field-of-view in excess of 4°. Includes coated, achromatic objective lens and crosshair eyepiece. Precise push-pull focusing. Thousands now in use. 2-ring bracket, with collimation screws and lock-nuts, included. Bracket fits all tubes 6" to 12½". **$24.95 ppd.**

9—6×30mm RIGHT-ANGLE VIEWFINDER—As in (8), but with diagonal prism for convenient right-angle observations. Prism may be rotated through 360° for maximum viewing comfort. 2-ring bracket included. **$29.95 ppd.**

Multi-Coated Series 2 and Research-Grade Eyepieces

Manufactured to entirely new Meade designs, these Series 2 eyepieces are a significant advance in eyepiece technology. Utilizing modern high-density optical glasses, each eyepiece has been computer optimized to yield the highest level of optical performance obtainable within its design class. **Air-to-glass surfaces on all Series 2 and Research-Grade eyepieces are Multi-Coated for maximum light transmission and image contrast.** All 1¼" barrels are threaded for Meade filters.

10—SERIES 2 MODIFIED ACHROMATIC EYEPIECES (1¼"O.D.; MULTI-COATED)—Fine 3-element systems, precisely corrected for chromatic and spherical aberrations. Guaranteed to be the finest eyepieces obtainable in their price class.
FOCAL LENGTHS: MA 6, 9, 12, 25mm and 40mm Wide-Field .... each $19.50 ppd.

11—MODIFIED ACHROMATIC 40mm EXTRA-WIDE-FIELD EYEPIECE (1¼" O.D.; MULTI-COATED)—Yields widest field obtainable in 1¼" O.D. Enlarged field lens and special field-flattening optics with long eye relief. **$27.75 ppd.**

12—SERIES 2 ORTHOSCOPIC EYEPIECES (1¼" or .965" O.D.; MULTI-COATED; PARFOCAL)—The excellent 4-element high resolution optics of these oculars are all that the majority of serious amateurs will ever require. Razor sharp 45° fields. Both the 1¼" and .965" O.D. sets are accurately parfocalized.
FOCAL LENGTHS: OR 4, 6, 9, 12.5, 18, and 25mm...each $27.95 ppd.

13—RESEARCH-GRADE ORTHOSCOPIC EYEPIECES (1¼" O.D.; MULTI-COATED; PARFOCAL)—The largest selling premium-quality eyepieces in the world, universally acclaimed to be the finest eyepieces obtainable. These 4-element systems are unsurpassed in color correction, resolution, and flatness of field. 45° field. Accurately parfocalized.
FOCAL LENGTHS: OR 4, 7, 10.5, 16.8, 28mm...each $44.50 ppd.

14—RESEARCH-GRADE ERFLE EYEPIECES (1¼"O.D.; MULTI-COATED; PARFOCAL)—For breathtaking wide-angle observations. 65° fields, parfocalized with our Research-Grade Orthoscopics.
FOCAL LENGTHS: ER 7, 12.4, 15.5, 20mm...each $49.50 ppd.

VIEWFINDERS—With helical focusers for ultraprecise control of image sharpness. Coated, achromatic objectives of new Meade design yield fully corrected images throughout the field. Actual field on 50mm models: 4¼°; on 60mm models: 3½°. Crosshair eyepiece, dewcap, dustcap included. The 60mm models are particularly recommended for telescopes 8" and larger, where the large finder apedure is a tremendous aid in the location of faint objects.

15—8×50mm—$47.50 ppd. Brackets: **$7.95/pr. ppd.**

16—8×50mm RIGHT-ANGLE—$54.50 ppd. Brackets: **$7.95/pr. ppd.**

17—GIANT 9×60mm—$72.00 ppd. Brackets: **$12.75/pr. ppd.**

18—GIANT 9×60mm RIGHT ANGLE—$79.00 ppd. Brackets: **$12.75/pr.**

19—RESEARCH-GRADE ERFLE 32mm EYEPIECE (2"O.D.; MULTI-COATED)—Wide-angle, fully-corrected 65° field. The finest eyepiece obtainable in 2" barrel. **$110.00 ppd.** Adapter Barrel for 1¼"O.D. ... **$12.50 ppd.**

20—DELUXE CAMERA ADAPTERS—Adapt your camera to telescope focuser instantly. Individually machined from solid bar aluminum and brass. All units permit both eyepiece-projection and first (prime) focus photography. Specify either 1¼" or .965" focuser. All 1¼" units are threaded for our filters. **Pentax, Yashica, Mamiya...$22.50 ppd.—Nikon, Canon, Minolta, Pentax K, Exakta, Konica, Olympus OM-1, OM-2...$29.75 ppd.**

21—2X TELENEGATIVE AMPLIFIER (1¼" O.D.; MULTI-COATED)—Model 122: Warranted without qualification to be the world's finest Barlow lens. Full 26mm clear aperture, Multi-Coated, with virtually flawless optical corrections at all photo-visual wavelengths. Produces optimum performance on telescopes of any focal ratio... **$29.50 ppd.** **Model 131:** Per Model 122, but for .965" focusers; 18mm clear aperture. Multi-Coated... **$24.50 ppd.**

22—2X-3X VARIABLE TELENEGATIVE AMPLIFIER (1¼" O.D.; MULTI-COATED)—Model 127: Manufactured to the same research standards as the Model 122 above, but mounted in a precisely machined sliding cell, to permit variable power settings between 2X and 3X. Engraved scale indicates power. Multi-Coated... **$39.95 ppd.**

23—PARABOLIC MIRRORS—The very finest. 1/10-wave, diffraction-limited primary mirrors. Aluminized and quartz overcoated. Immediate shipment.
6" f/8...$65.00 ppd.; 6"f/5...$75.00 ppd.; 8" f/6...$95.00 ppd.; 10" f/6...$175.00 ppd.; 12½" f/6...$295.00 ppd.

24—SECONDARY MIRRORS—Elliptical 1/10-wave flats. Aluminized and overcoated. Immediate shipment. **1.30" M.A....$12.00 ppd.; 1.52" M.A....$16.00 ppd.; 1.83" M.A....$19.50 ppd.; 2.14" M.A....$23.00 ppd.; 2.60" M.A....$27.50 ppd.**

25—ILLUMINATED RETICLE GUIDING EYEPIECE (1¼" or .965" O.D.)—New phosphorescent etched double-line reticle permits line illumination from dim to extremely bright. Remote brightness control and 6 ft. cable. Modified Achromatic 12mm optical system. Precisely focusable reticle. Complete... **$49.95 ppd.**
Micrometer Reticle. Full-field scale for accurate measurements of double star separations, planetary angular diameters, etc. Interchanges with standard 4-line reticle... **$19.50 ppd.**

26—ERECTING PRISMS—Fully coated Porro prisms, for terrestrial observations with astronomical telescopes. **1¼" O.D. ...$32.95 ppd.**
.965" O.D. ...$27.95 ppd.

27—DIAGONAL PRISMS—Quality right angle prisms, fully coated. **1¼" O.D. ...$22.95 ppd.—.965" O.D. ...$16.95 ppd.**

10

11

12

13

14

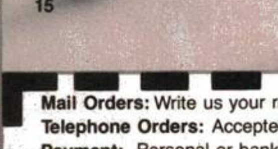
1

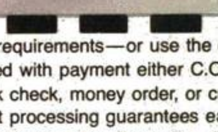
2

3

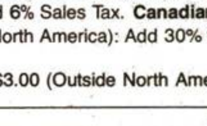
4

5


17


18

15


16

8

9

6

7

19

20

21

23

22

24

25

26

27

Mail Orders: Write us your requirements—or use the order form which accompanies our catalog.
Telephone Orders: Accepted with payment either C.O.D. or credit card (we do not accept collect calls).
Payment: Personal or bank check, money order, or credit card (VISA or Master Charge).
Prompt Shipment: Our fast processing guarantees early delivery of your order.
California Residents: Add 6% Sales Tax. **Canadian Orders:** Add 10% to cover priority mail charges.
Foreign Orders (outside North America): Add 30% to cover Air Parcel Post charges. Payment must be made by bank check in US $.
General Catalog 81-C—$3.00 (Outside North America $5.00 for Air Mail). (Catalog free with any order.)

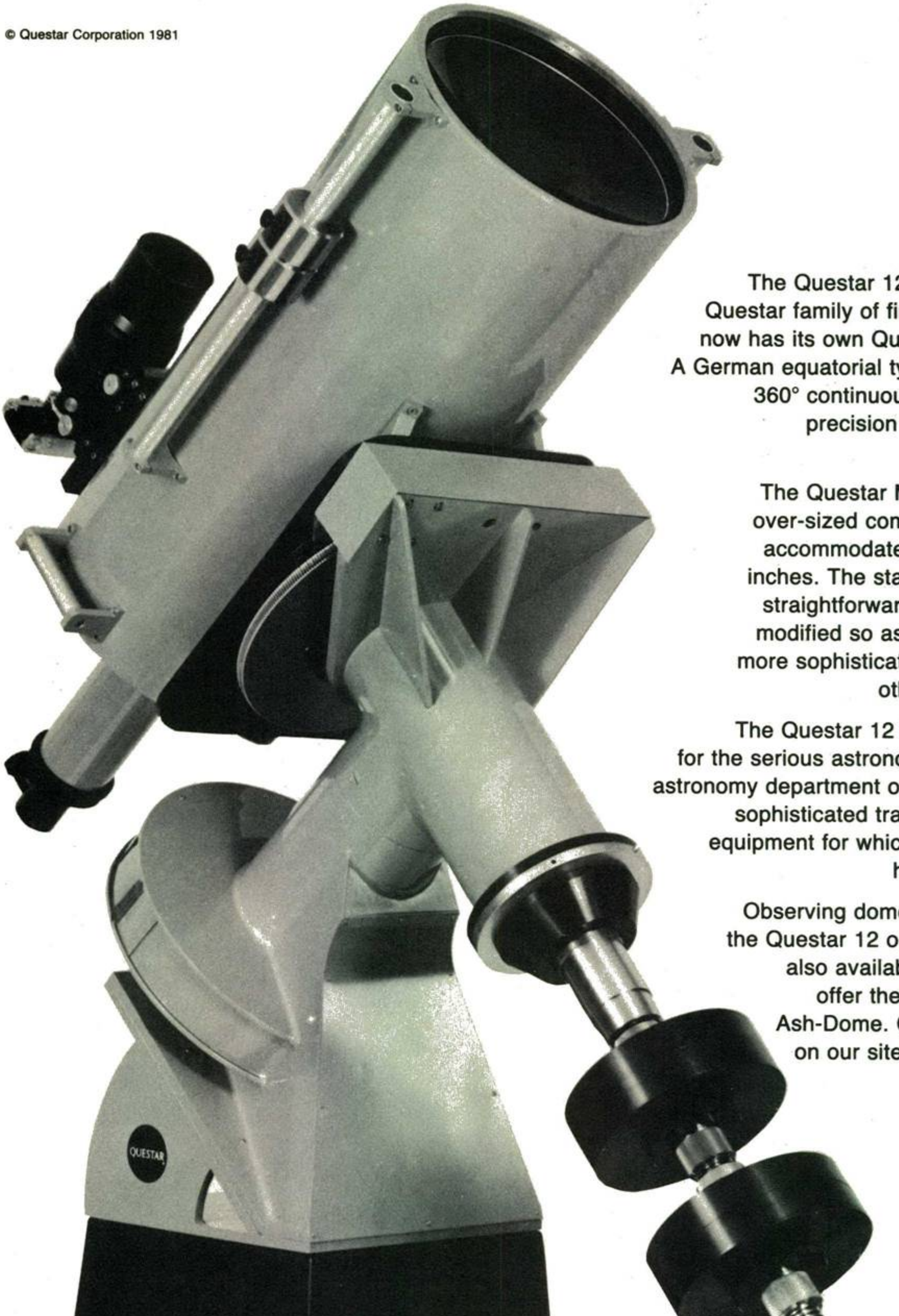
Card No. ______________________ Expiration Date / /
Name ______________________
Address ______________________
City ______________________ State ________ Zip ________

Meade Instruments Corporation 1675 Toronto Way, Costa Mesa, Calif. 92626 • **(714) 556-2291**

© 1980 Meade Instruments Corp. TM Series 2, Research-Grade, Fiberlite, VariGuide, and VariPak are trademarks of Meade Instruments Corp.

QUESTAR® 12 on the QUESTAR® MOUNT

© Questar Corporation 1981



The Questar 12, latest addition to the Questar family of fine optical instruments, now has its own Questar-designed mount. A German equatorial type, it is notable for its 360° continuous tracking in R.A. with precision tracking to better than 4 arc seconds.

The Questar Mount is designed with over-sized components so that it can accommodate any Questar up to 18 inches. The standard mount shown is straightforward in design but can be modified so as to be compatible with more sophisticated tracking devices or other special equipment.

The Questar 12 is a superb instrument for the serious astronomer, for the university astronomy department or the engineer seeking sophisticated tracking and surveillance equipment for which Questar Corporation has a noted reputation.

Observing domes suitable for housing the Questar 12 or larger telescopes are also available at Questar. We can offer the Observa-Dome or the Ash-Dome. Come see one erected on our site here near New Hope.

For literature write to
Questar Corporation

Box C, Dept. 80, New Hope, Pa. 18938 (215) 862-5277

the shoot out: cold camera vs. gas hypering

photography in astronomy

by
Bill Iburg

Cold cameras have been considered the astrophotographer's state-of-the-art tool for high quality deep-sky color photography. Although the results produced by cooling color emulsions are spectacular, the tiresome and painstaking procedure and the threat of frostbitten fingers are enough to make even the most die-hard astrophotographer yearn for a simpler solution. The advent of gas-hypering techniques and equipment suggested an alternative to the drudgery of cold camera photography.

The merits of hypering both color and black-and-white films have caused some debate between astrophotographers. Most photographers agree that hypered 2415 film is the best method for black-and-white deep-sky photography — the gain in resolution and decrease in grain over the spectroscopic emulsion are nothing short of amazing — but tests of gas-hypered color films as compared to cooled color emulsions have not been as conclusive.

Hypering various color films such as Ektachrome 400 or Fuji 400 produces results far superior to using these films unhypered; but how do these hypered films really compare with cold-camera photographs taken under identical conditions? To answer this question, I decided to compare Ektachrome 400 in the cold camera with various hypered films, including Ektachrome 400, Fuji 400 and Fuji 100. The critical part of this experiment was controlling all the variables so the results would be meaningful. (The general procedure for hypering film is outlined in Photography in Astronomy, ASTRONOMY, April and May 1981.)

I hypered all films for this experiment on an open reel in forming gas (92% Nitrogen, 8% Hydrogen), at 50° C. The first problem — and the most time-consuming part of the procedure — was to determine proper gassing times for the three films. To do this, I hypered each film for 3, 6, 9, 12 and 15 hours and then had them developed by the same commercial lab. The films were carefully examined and compared to unhypered film — used as a control — to determine the optimum gassing time for each, which occurs just before the point that fogging becomes objectionable. I found that the best times for Ektachrome 400, Fuji 400 and Fuji 100 were 12, 8 and 10 hours respectively.

A 25-minute cold-camera exposure on Ektachrome 400 was used for this shot of the globular cluster, M-28. Advanced techniques like chilling or hypersensitizing film emulsions with special gases enable backyard astrophotographers to record those faint smudges we see in the eyepiece.

To avoid any differences in storage time and to keep them as fresh as possible, I hypered all three films simultaneously the night before the actual photography took place. After eight hours I removed the Fuji 400 and continued hypering the other films. Two hours later I removed the Fuji 100, and two hours after that, the Ektachrome 400.

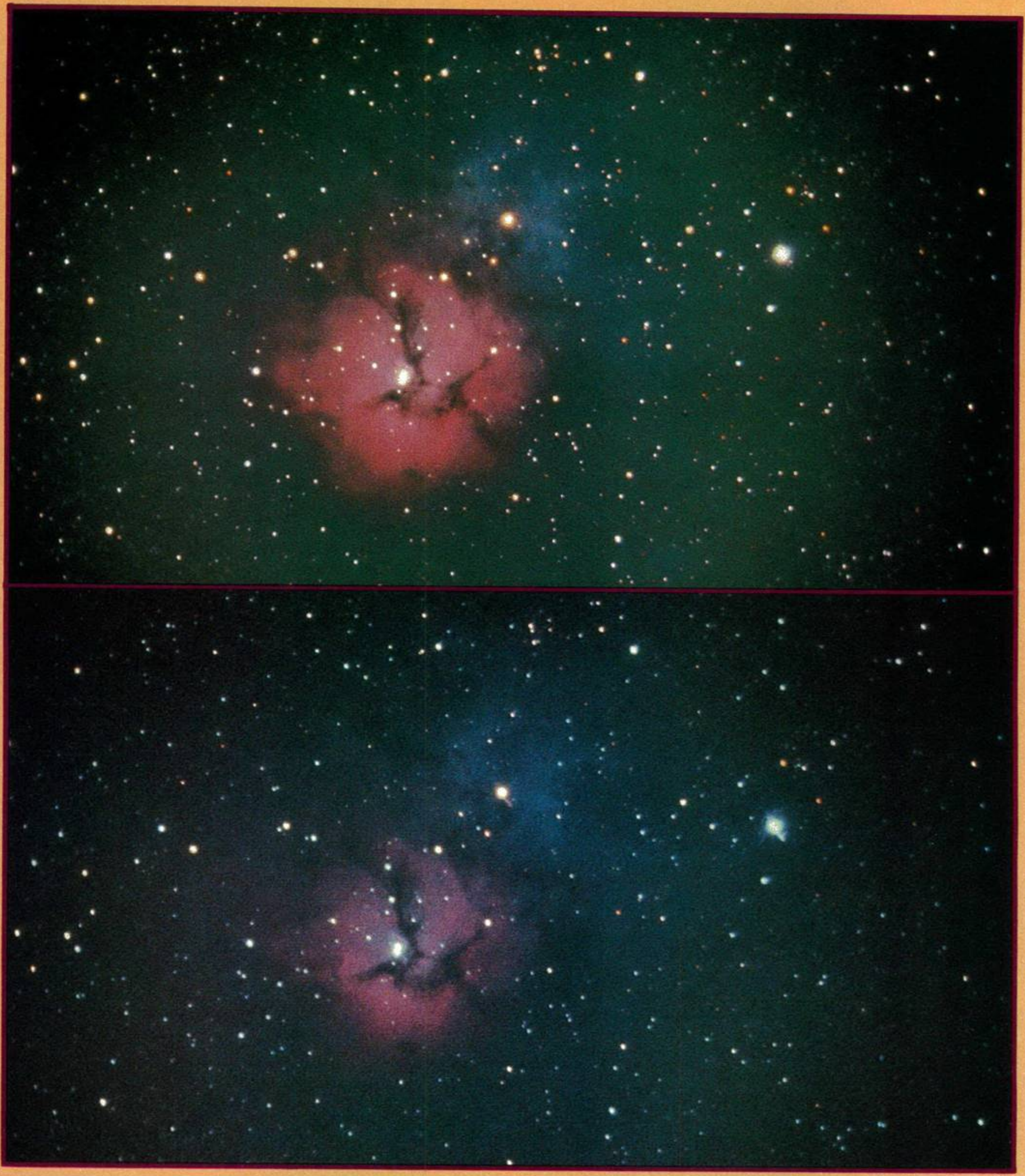
I chose the Trifid Nebula (M-20) as the test object because of the presence of both blue and red nebulosity, and I took all four photos one after the other using a Celestron 11 and a Celestron-Williams cold camera as the film holder. Each exposure lasted 30 minutes. I focused the camera very carefully and exposed all four films using the same focus. Although I usually re-focus for each photo, I decided not to for this experiment in order to eliminate the possibility that differences in the focus would be misinterpreted as variations in resolving power of the films. Fortunately, the focus was good and all four photos came out fine. The Trifid was crossing the meridian during all the exposures and seeing conditions remained excellent throughout the test.

I developed all four films at home the following morning in the same developing tank using Kodak's E-6 processing kit. The resulting transparencies show some very interesting comparisons.

The cold-camera photo on Ektachrome 400 exhibited its typical greenish background with good red and blue response. I prefer Ektachrome 400 over other transparency films because of its excellent color balance and fine recording power, and I use it as my standard color film. The greenish background is of little consequence and can be be removed when making prints or slide copies from the original. Contrast is also reasonably good.

The Ektachrome 400 was by far the best of the three hypered films. It had a slight bluish shift compared to the cold-camera photo and produced a more natural looking background. However, contrast was lower and grain was also slightly more pronounced. It did not record as much nebulosity or as many of the fainter background stars as the cooled emulsion.

Hypered Ektachrome 400 is an excellent choice for color



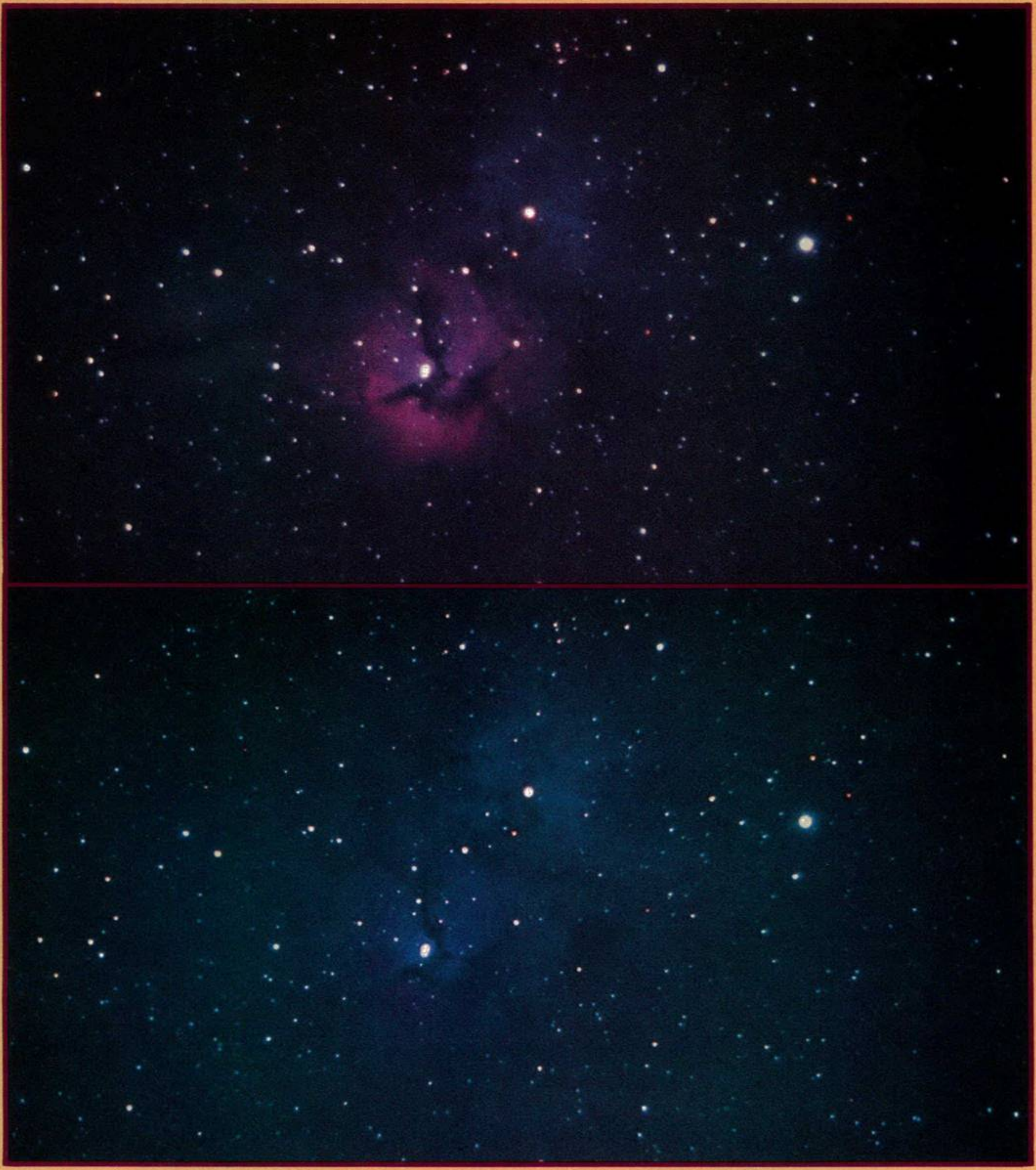
All 30-minute exposures are not created equal — as these shots of M-20 show. The top photo was taken with a cold camera. Hypersensitized Ektachrome 400 recorded the bottom photo. Facing page top is hypered Fuji 400, and Fuji 100 is at the bottom right. Experimentation is the only way to test films for astrophotography.

astrophotography when you want fairly decent results without the hassles of fighting a cold camera most of the night. You can also avoid the home development of single frames of film that cold camera use dictates. Instead, you can shoot an entire roll and have it processed commercially. In other words, you'll skip a lot of needless aggravation by hypering.

The Fuji 400 exhibited a magenta cast and, as a result, color balance was not as good as in the Ektachrome 400. Star images were slightly sharper, but the recording power was a shade less than hypered Ektachrome 400.

Fuji 100 held the highest promise for low grain and high resolution, but was disappointing in other respects. The color balance was shifted so far into the blue that even the red portion of the Trifid had a bluish tone. Grain was unquestionably less apparent than in the other three shots, but substantially less of the nebulosity recorded could be seen than with the Ektachrome 400.

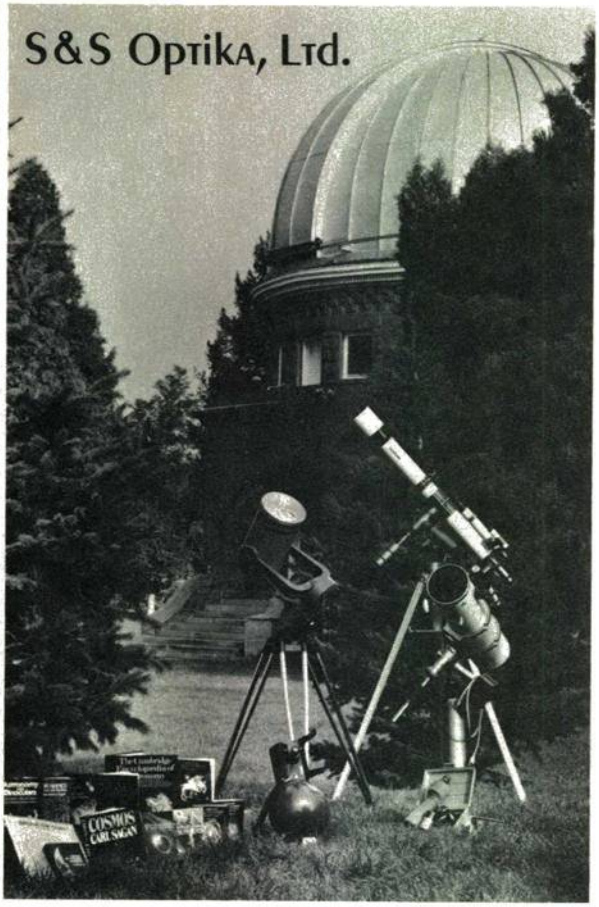
These results are only a beginning when you consider the possibilities that can be explored using color



emulsions for astrophotography. Some preliminary tests I've run show that, with certain films, hypering and cooling the emulsion can have additive effects. For example, hypered Kodacolor II in a cold camera produced results far superior to either hypered or cooled Kodacolor II separately. Hypered Kodacolor II was bluish when shot alone, but when used in a cold camera it recorded more nebulosity, and its color balance was excellent.

This suggests some exciting possibilities for experimenting with very fine grain color emulsions. What are the results of hypering Ektachrome 64 or Kodachrome 25 or 64, and then cooling the emulsions, or perhaps doing the same with photomicrography film? Maybe the best results will turn out to be a combination of both cold camera use and gas hypering. And then, of course, there is always the hope that someone is brewing a new color emulsion that will do for color what 2415 did for black-and-white. The future of color astrophotography needs more research, but it is very exciting indeed. And because astrophotography is such a highly specialized area, it's up to us backyard astronomers to test these commercial films in our own applications.

Bill Iburg is a California-based amateur astronomer. He took all the photos accompanying this article.



NEED SOME IDEAS FOR CHRISTMAS?

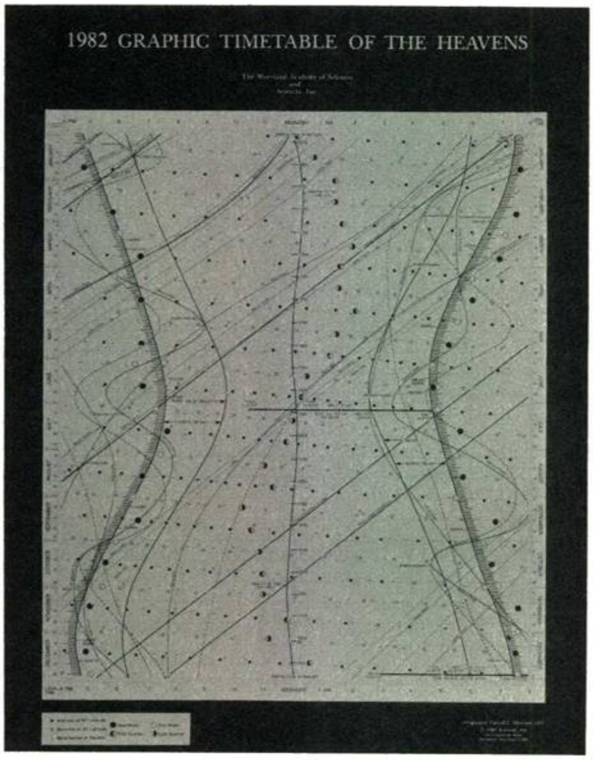
Here are a few suggestions, in every price range.

Pentax 100 Refractor with Clock Drive	1,980.00
Celestron 8 Telescope: Minimum Service Package	845.00
Full Service Package	995.00
Wedge for C-8	47.50
Tripod for C-8	130.00
Meade 6" f/5 Reflecting Telescope (F.O.B.Calif.)	464.95
Bushnell 20 - 45x Spacemaster Spotting Scope	295.00
Astroscan 2001 with Star Atlas	209.00
Cambridge Encyclopedia of Astronomy	40.00
Burnham's Celestrial Handbooks (3 Volumes)	27.85
Cosmos (Carl Sagan)	19.95
Astronomy with Binoculars (J. Muirden)	10.95
Seasonal Star Charts	8.95
The Planet Saturn	8.00
Sunspots	7.00
Amateur Astronomers Handbook (Sidgwick)	6.95
Star Names: Their Lore and Meanings	6.00
Sky Shooting: Photography for Amateur Astronomers Mayall)	3.50
1982 Daily Planet Almanac	3.95
Accessory Case (holds 6 eyepieces, Camera Adapters, etc.)	14.00

All items F.O.B. Denver, except as noted.

Christmas is just a few hours east of our meridian.
Start being creative now.

3855 S. Broadway • Englewood, CO 80110 • (303)789-1089



Copyright© 1982 by Scientia, Inc.

Track the Movements of the Planets, the Sun and the Moon with the 1982 Graphic Timetable of the Heavens

The 1982 Graphic Timetable of the Heavens displays the motions of all major solar system bodies for the entire year. You'll know when the Moon and planets rise and set; when conjunctions occur; and when eclipses, transits, elongations, solstices and lunar phases take place. The easy-to-follow grid allows you to pinpoint all these heavenly bodies for any date and time.

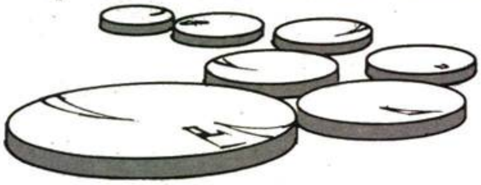
Printed in 6 colors, this informative chart measures 17" x 22". A classic amateur reference, the **1982 Graphic Timetable of the Heavens** is the perfect tool for observational astronomy.

$6.95 includes postage and handling

To order, use the AstroMedia form bound into this magazine.

Large Aperture Optics

The Emphasis Is On Performance!



These optics reflect today's demand for both easy portability and high performance. Even the smallest mirror (10") is capable of revealing structure in the galaxies and, with unfinished 16" standard Pyrex blanks selling for more than $700, our largest (17.5") mirror at $659.50 is the best optical buy in the world.

New lightweight mirrors

Truly revolutionary in optics today, these mirrors offer same high performance of conventional high-quality mirrors — at less than half the weight. Purchasers outside the U.S. will find cost and weight-limitation problems of heavy-mirror shipping eliminated. Build the lightweight, compact, large aperture telescope you have always wanted. Mirrors can be mounted as standard, flat-back or flotation cells. Null figured, paraboloidal Pyrex mirrors, aluminized and overcoated, free of astigmatism, approximately 13-1 diameter-to-thickness ratio. Full instructions included. Satisfaction guaranteed.

10" f/4 — $199.50	12½" f/4 — $357.50
10" f/5.6 — $129.50	12½" f/6 — $249.50

Mirrors with 6 to 1 ratio blanks

Same specifications as lightweight mirrors, except blank ratio.

10" f/5.6 — $139.50	12½" f/6 — $259.50

17.5" f/4.5 Optics $659^50

Now, for the first time, it is possible to build an observatory-class telescope at a reasonable cost with this set of optics. See the dramatic new dimension offered by increased aperture. Virtually every NGC object can be detected. Faint, undefinable shapes become objects in startling detail. There is no better way to increase your interest and enjoyment in the universe. Null figured, paraboloidal Pyrex mirror, 17.5" dia. x 1½" thick, with 4.25" Pyrex flat. Both coated. Instructions included

Elliptical Diagonals

These coated flats are ready to mount and use. They are low priced and available in a wide selection. 1/10 wave guaranteed. Choose minor axis below.

0.75" — $6.95	1.52" — $13.50	2.14" — $18.95	3.10" — $34.50
1.30" — $9.50	1.83" — $15.50	2.60" — $22.50	4.25" — $99.50

Astronomical optics prices include shipping in the 48 contiguous states. Shipping costs are additional other destinations. California residents add 6% sales tax.

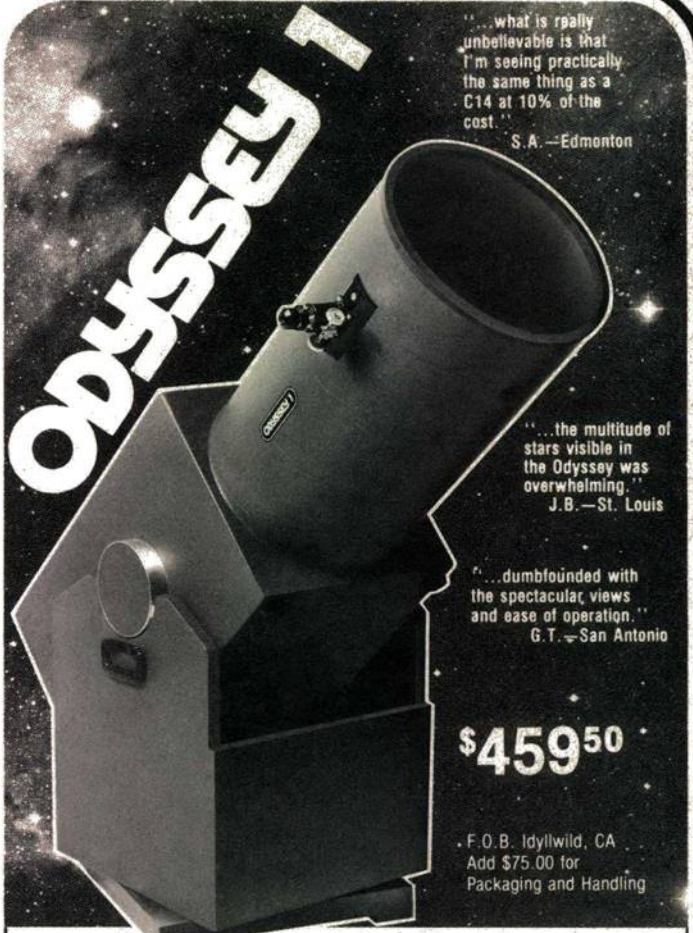
VISA and MasterCard Accepted

Visit our Showroom at 54141 Pinecrest Road
Showroom Hours Mon.-Fri. 8-4:30 Sat. 12-4

Write for Free Literature to:

Coulter Optical Company

DEPT. A BOX K IDYLLWILD, CA 92349
TELEPHONE 714 659-4621



"...what is really unbelievable is that I'm seeing practically the same thing as a C14 at 10% of the cost."
S.A.—Edmonton

"...the multitude of stars visible in the Odyssey was overwhelming."
J.B.—St. Louis

"...dumbfounded with the spectacular views and ease of operation."
G.T.—San Antonio

$459^50

F.O.B. Idyllwild, CA
Add $75.00 for Packaging and Handling

Breaks the Aperture Barrier to Change the Way You See the Universe

Since Lord Rosse discovered the spiral structure of M51 through his 72" Leviathan of Parsontown in 1845, few amateur astronomers have been able to afford instruments which enabled them to share his excitement and pleasure. Now the 1 3.1" aperture of Odyssey I bridges that 136-year *performance gap* to reveal the universe more vividly than ever before at such modest cost. Priced in the range of most 8" telescopes, Odyssey I clearly shows the spiral arms of M51. It brings out color in the Orion Nebula, shows the dust lanes in the Andromeda Galaxy, lets you see the elusive Veil Nebula, reveals thousands of NGC objects, and provides intricate lunar/planetary detail.

Odyssey I is leading the way with dramatic new concepts revolutionizing telescopes used by amateur observers, literally changing the telescope as we know it today. Imagine a telescope that easily reveals structure in the galaxies and shows the universe visually equalized (the correct size-to-brilliance relationship of extended objects viewed through a telescope). That is what Odyssey I offers you and now there is no reason for you to be satisfied with less. EXPERIENCE THE UNIVERSE.

SPECIFICATIONS

13.1" dia. f/4.5 paraboloidal Pyrex mirror, null figured aluminized and coated. ☐ 3.1" minor axis elliptical diagonal flat $\frac{1}{10}$ wave aluminized and coated. ☐ 9 pt. flotation system. ☐ 3 pt. collimation adjustment. ☐ 25mm coated Kellner eyepiece with 1¼ rack-and-pinion focuser. ☐ Dobsonian alt-azimuth Mount. ☐ Anti-backlash Teflon bearings throughout for smooth operation. ☐ Blue Zolatone finish. ☐ Ready to use. ☐ Weight, 130 lbs.

equipment atlas

stellafane and the art of telescope making

The growth of any hobby — even something as esoteric as making and using telescopes — requires regular contact between people. No matter how much you read, or how profoundly you think about it on your own, you'll spend your life reinventing the wheel if you don't see what other people with the same interests are doing.

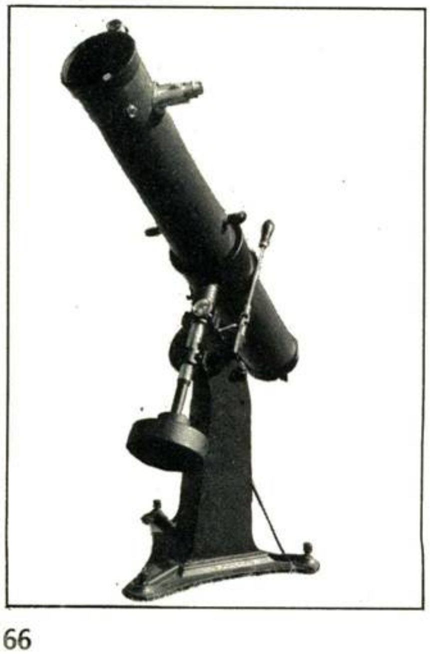
For over fifty years, the annual Stellafane meeting, sponsored by the Springfield Telescope Makers and the ATMs of Boston, has provided a place for the meeting of telescopic minds on a little hill just outside Springfield, Vermont. (See "Shrine to the Stars," ASTRONOMY, November 1980.) In 1981, for the 46th convention, well over 1,000 people attended Stellafane. Many of them displayed telescopes of every size and description on the rocky open areas atop Breezy Hill in front of the little pink clubhouse. Others swapped stories about mirror grinding techniques, exchanged leads on where to buy optical glass for less, and renewed old acquaintances made at Stellafanes past.

There was a swap table where you could get a bargain on an old aerial camera lens, or pick up a homemade 6-inch mirror for the RFT you always wanted to build, or find copies of mildewed *National Geographics* with stories about space from the late '50s, or even buy a hand-embroidered telescope tube cover!

There were informal talks under a tent behind the clubhouse: a ten-minute show about a new observatory put on by the club that just built it, an optical expert telling how to put the best figure on a mirror for a big Dobsonian, and a talk followed by a live demonstration — in an old tool shed — of a televised, digitized optical tester.

This year, Stellafane participants saw the largest telescope that's ever been on the hill — a 22-inch f/7.3 Dobsonian on an equatorially tracking Poncet platform mounted on a trailer. It was made by Steve Dodson of North Bay, Ontario. This telescope, which arrived just barely finished, represents the convergence of trends toward large apertures, Dobsonian mountings, and the application of Frenchman Adrian Poncet's brilliant scheme for equatorial tracking. It also satisfies the modern mania for portability. When the bugs get ironed out, the Poncet type of mounting will permit big Dobsonians to track the stars — without the

Far left: Dating from the 1880s, this 5.5-inch f/10 restored reflector leaves little to ask for in performance, stability, or ease of use. Below: Displayed by its owners — sometime before 1900, in Macon, Missouri — the telescope was housed in a roll-off roof observatory. Photograph courtesy Kenneth Launie. Right: Steve and Hélène Dodson stand beside his 22-inch Dobsonian reflector, the largest telescope ever on the hill. Reaching the eyepiece may take 10 to 12 steps up the ladder.



1930
766 44F
TRAILER

Above: On Saturday night, observers crowded around telescopes under crystal clear Vermont skies, while the stars trailed overhead. The 22-inch telescope is silhouetted against the Springfield Telescope Maker's clubhouse and the famous Porter Turret Telescope. Inset: Telescope talent for the future, Steve Scotten poses with the 4.25-inch f/10 reflector he built himself.

expense of a full equatorial mount.

Another impressive telescope, though not by virtue of its size, was a reflector built circa 1885, and beautifully restored by Kenneth Launie and Rick Schmidt of Stoneham and Scituate, Massachusetts. The telescope is a commercially built 5.5-inch f/10 reflector — nothing unusual there — but noteworthy because nearly 100 years later, there are no telescopes of comparable sturdiness on the market! Unlike many telescopes today, it did not shake when eyepieces were changed, nor shimmy in a gentle breeze, nor fall back when you took your hands off after setting it on an object. Finished in ruddy brown and black, and gleaming with brass, it was a fine looking instrument.

Stellafane also provides a glimpse at the future — not just the past — of telescope making, and offers proof that the art will continue. Particularly notable in this respect were two telescopes — one built by 11-year-old Steven Scotten of Springfield, and the other by eight-year-old Alan Beaman of Rockford, Illinois. Both boys had made 4.25-inch reflectors, and both had ground and figured their own mirrors (with some parental help). Steve's telescope rides on a little Dobsonian mount, and Alan's was built from plans for an inverted fork mount published in the October 1978 ASTRONOMY, although he made a shorter tube for his f/7 mirror.

But Stellafane is a good deal more than the past and future of telescope making and all the hardware in between. It is the "here and now" of 1,000 people crowding a hill in Vermont saying "Oooo" each time an early Perseid streaks across the dark and clear Vermont sky. It is scores of new ideas exchanged on the building and use of telescopes. It is 1,000 people learning from each other at the biggest star party in the world.

— *Richard Berry*

**IMITATED
BUT NOT YET
EQUALLED**

RV-6
6-INCH
DYNASCOPE®

There Is Simply Nothing Like It At Anywhere Near Its Price

Including... Electric Drive, 2 coated eyepieces (threaded for filters), setting circles, 6x30 finder, rotating tube and more.

See For Yourself Why This Famous RV-6 Dynascope May Well Be The Most Popular 6-Inch Telescope In The World Today

More amateurs, professionals, schools and colleges have bought it, used it, recommended it and endorsed it than any other kind. It has been proven in use far beyond any other.

Recognition of the RV-6 among schools, colleges, professionals and expert amateur astronomers is beyond question. No other instrument of its kind has been more proved in use or more widely praised and enthusiastically accepted. Thousands upon thousands of RV-6 Dynascopes prove our engineering leadership. Certainly, more 6" Dynascopes are in use throughout the world today than any other competing model.

Yes, there must be good reasons why more people have chosen it, more experts endorse it than any other 6" Newtonian. And the reasons for its overwhelming Number One rating are simple: more quality, more performance, more value.

Consider, for instance, the superb optical system accurate to better than 1/10 wave, which flawlessly resolves even the most difficult objects with breathtaking ease. Or the heavy duty equatorial mount in which all castings are precision machined to better than .001," providing the stability so necessary for satisfactory viewing and long exposure astrophotography. Because of superb design and precision construction, the entire instrument is as completely rigid and wobble-free as it is simple and easy to use. All materials, long tested in field use, meet extreme durability standards—right down to our new solid stainless steel declination shaft which cannot rust even through a lifetime of use. In comparing value, what other telescope in this price range offers the everlasting quality and close tolerances of solid stainless steel? Or the extra value of Achromatized Symmetrical eyepieces of Plössl quality (superior to both Ramsden and Kellner types), whose brass barrels are threaded to accept filters? Then again, what other telescope in this price range or higher offers you a 60-day unconditional guarantee of satisfaction to back up its advertising claims?

Yet, modern production engineering holds the costs to levels that permit our remarkable price of $359.95, complete—not for a "stripped" model, but for the fully equipped RV-6 Dynascope that has won such unprecedented user pride and loyalty. You can order your RV-6 today with complete confidence that it will live up to your expectations in every way, or we will refund every cent you paid for product under our unique 60-day money-back guarantee. Send your check or money order today.

Model RV-6 Complete with Dyn-O-Matic Electric Drive and All Features Described Below

$359.95 F.O.B. Hartford, CT

Back By Popular Demand... Model RV-8

Identical to the RV-6, but includes a manual declination slow motion, longer declination axle, extra counterweight and of course an 8" f/8 optical system.

$589.95

$15 Crating Charge

You Could Pay $100 More Without Getting All These Superior Features
(Except on Another Dynascope)

1. Exquisite Optical System—Includes f/8 6-inch parabolic mirror accurate to better than 1/10 wave, zircon quartz coated, guaranteed and proven in use to be the finest 6-inch Newtonian optical system obtainable—even when compared to 6-inch telescopes costing far more.

2. New Dyn-O-Matic Electric Drive with smooth self-acting clutch that engages and disengages automatically as you seek different objects. Will not interfere when manual operation is desired. Safety housed case. Plugs into ordinary AC socket.

3. Two High Performance Eyepieces—70X (18 mm.), Symmetrical; 140X (9 mm.), 1¼" dia., precision threaded, coated. Also available, extra Symmetricals: 40X (30 mm.), $25.00; 100X (12.7 mm.), $25.00; 180X (7 mm.), $25.00; 220X (6 mm.) Orthoscopic, $28.00; 320X (4 mm.) Orthoscopic, $28.00; 16.3 Erfle Wide Angle, $35.00; CP4 Achromatic Barlow to double powers, $22.50. All give sharpest images to extreme edges. Brass barrels of all Criterion eyepieces are threaded for filters.

4. Solid New Equatorial Mount—Precision machined to better than .001", assuring pillarlike stability during observation or long exposure work. No annoying side play or wobble. Solid Stainless Steel Declination axle can never rust, unlike other 6-inch telescopes. Adjusts easily to any latitude.

5. Setting Circles for both Right Ascension and Declination. Handsomely engraved and finished in fine aluminum. Read directly into the sky for easy acquisition of faint objects.

6. 6x30 Finderscope, Achromatic, Coated, with accurate crosshairs and precision micrometer screw focus. Focus "stays put" unlike sliding draw tube spy-glass types. 6 adjusting screws provide positive collimation.

7. Rotating Rings for Maximum Versatility and Viewing Comfort—Solid-cast, chrome finish, rings are generous 1" wide with felt lining. Newly designed construction, with over-sized knurled adjusting knobs, affords maximum rigidity and allows for quick disassembly and portability, with or without tube.

8. Strikingly Handsome, White 50" Bakelite Tube with porcelainized Duralite finish, durable yet light. Walls are 1/8" thick, completely insulated and anti-reflective blackened inside. Dimensionally stable, maintains perfect collimation at all times.

9. Brass Rack-and-Pinion Eyepiece Holder has precision-cut worm and gear for easier, smoother, more positive focusing. Takes standard 1-1/4" oculars, negative or positive.

10. Strong, Vibration-Free, All-Metal Tripod with easily removable legs. Provides sure, steady support, plus lightweight portability.

11. Excellent Photographic Capabilities—Factory settings for both prime focus and eyepiece projection astrophotography are included upon request at no extra charge! Superb lunar, planetary and deep space photos are easily obtainable by the average amateur.

12. Optional Accessories—A complete system of optical accessories is available to cover the amateur's every need, including drive correctors, camera adapters for both prime focus and eyepiece projection work, eyepieces, filters, and more.

PROOF IS IN THE USING —OUR GUARANTEE

When comparing telescopes, be sure to compare guarantees. Be cautious of guarantees whose time limit does not permit ample time to thoroughly evaluate the telescope. For instance, a new telescope owner may frequently require several weeks or more to get used to his instrument before a defect is found (remember also that atmospheric conditions may prevent optical testing for long periods of time). For this reason, we give you a 60-day money-back guarantee. During this period, if you find the RV-6 is not everything we advertise it to be, if it does not measure up to other 6" telescopes you compare it to, you can return the instrument for a full refund. Please return product freight prepaid, insured, properly packaged and marked Attention Customer Relations Department, Criterion Scientific Instruments. Our guarantee is your assurance that the RV-6 is the best 6" Newtonian you can buy.

CSi

Criterion Scientific Instruments
620 Oakwood Ave., West Hartford, Conn. 06110
Manufacturers of Quality Optical Instruments **203-247-1696**

Criterion Scientific Instruments
Dept. CAS-106, 620 Oakwood Ave., West Hartford, CT 06110

☐ Please send me, under your unconditional guarantee, the RV-6 6-inch Dynascope. Payment of $359.95 is enclosed.

☐ Please send me, under your unconditional guarantee, the RV-8 8-inch Dynascope. Payment of $589.95 is enclosed.

☐ Charge to my credit card
☐ American Express ☐ VISA/BankAmericard ☐ Master Charge
Card No.________________Expiration Date________________

☐ Send FREE ILLUSTRATED LITERATURE describing the RV-6 6-inch Dynascope and all other telescopes in the Dynascope line.

☐ Send FREE ILLUSTRATED LITERATURE on your new DYNATRACKER Variable Speed Control for RV-6 or other electric drive telescopes.

Name (Print) Signature (If credit card)

Address

City State Zip

POSTER GALLERY

Earth, sky deep space, the universe — The definitive collection of space art from ASTRONOMY

To order, write poster name and artist on the AstroMedia order form bound into this magazine. All posters are in stock for immediate delivery, and will be shipped in sturdy containers to arrive intact and ready to hang.

PLANETS
GEOPHYSICS
ATMOSPHERES
GEOLOGY

A. Planets by NASA: 32" x 56" $4.95
A huge poster, with current information and pictures that explain the solar system. Fine for classroom or club.

Space Shuttle
NASA Facts
United States
USA

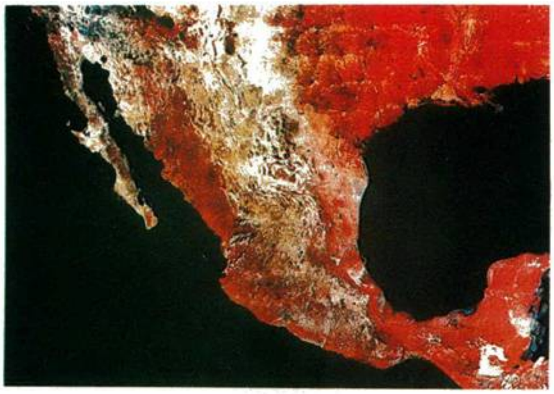
B. Space Shuttle by NASA: 30" x 42" $3.95
Another giant poster, revealing fine detail, complete with specs.

saturn
from pioneer II

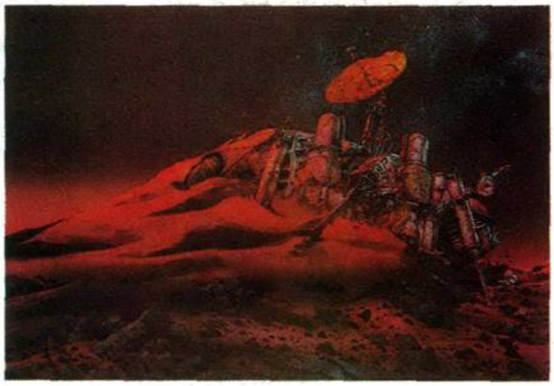
C. Saturn from Pioneer: 17" x 22" $3.95
Best image from the Pioneer flyby. A most unusual perspective of the jewel of the solar system.

the night face of north america

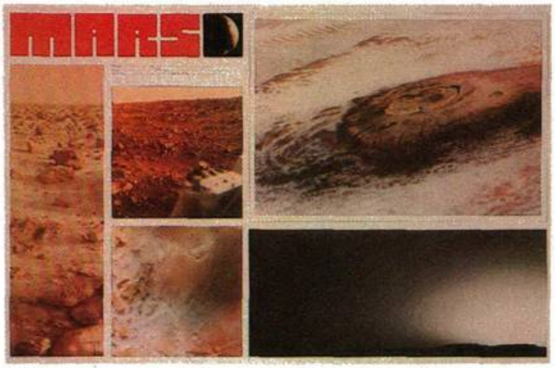
D. Night Face of North America: 17" x 22" $3.95
Our best seller pictures the lights of every city over 5,000 in the United States. Find your home town!



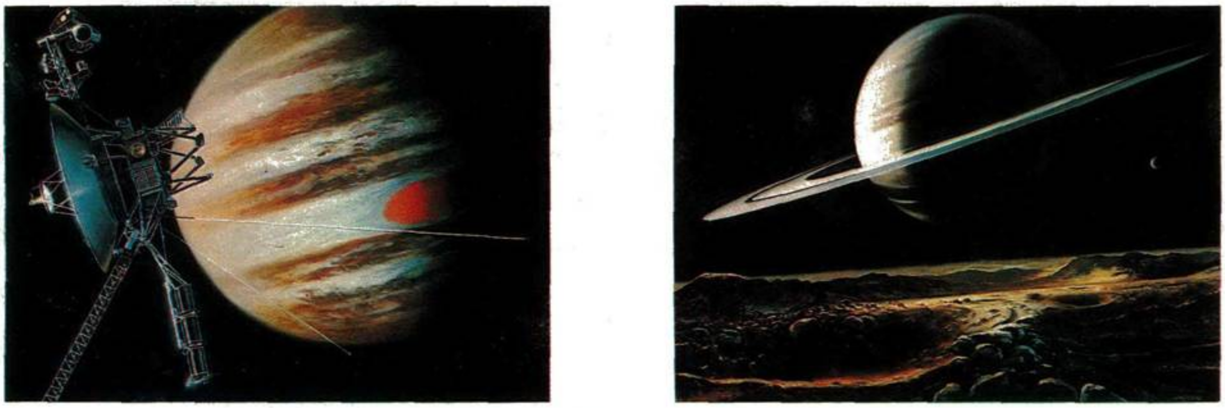
E. Mexico by LANDSAT: 22" x 34" $10.00
Magnificent, highly-detailed composite from satellite photographs, shown in bold color on heavy stock.



F. Viking at Mars: 24" x 36" $7.95
Artist Bruce Bond captures our pioneer spirit in this illustration of how Viking 1 might look thousands of years from now.



G. Mars: 22" x 34" $5.95
15 miles high and 400 miles wide, Olympus Mons dominates this dramatic poster.

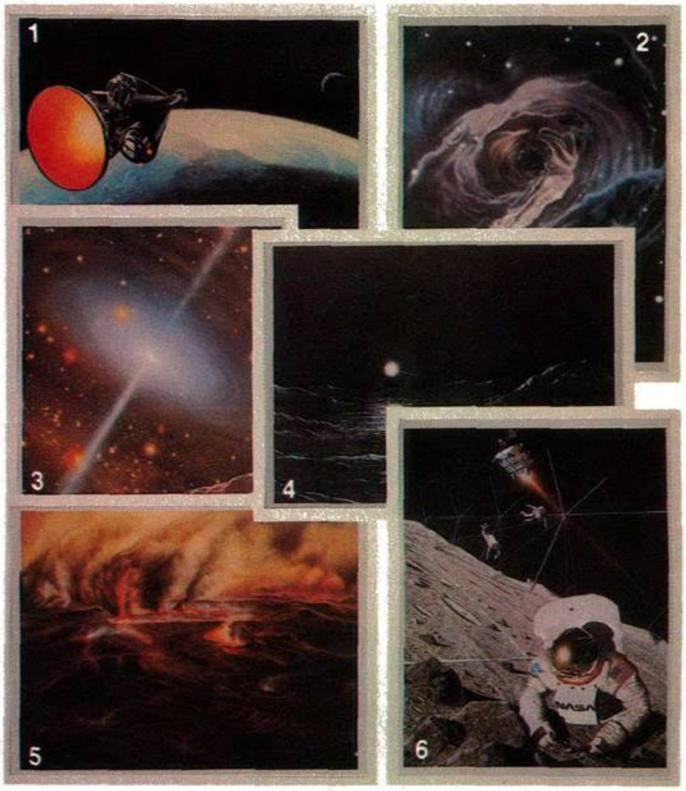


H. Jupiter & J. Saturn: 22" x 34" $12.00 each
Superior reproductions of John Clark's work commissioned by ASTRONOMY. Explorer examines the Red Spot of Jupiter in the first, while ringed Saturn looms above a rocky moon in the second. Order the set for $20.00 and save $4.00

K. Space Art Collection: 17" x 22" $2.95 each, all 6 for $12.95

Each illustration was featured in an ASTRONOMY article. These very popular pieces are an inexpensive trip to deep space.

1. *Zeta Reticuli by John Clark*
2. *Black Hole by Mark Paternostro*
3. *Radio Black Hole by Adolph Schaller*
4. *The Sun from Pluto by James Hervat*
5. *Tharsis Erupting by Mark Paternostro*
6. *Asteroid Miners by David Egge*



AstroNews

New Theory Proposed on Galactic Evolution

Using a computer instead of a telescope, a 25-year-old Australian National University student has solved a major astronomical puzzle and established what astronomers call the first convincing theory to explain how galaxies attain their shape.

The university claims the theory has aroused considerable interest in international astronomy circles and is likely to change accepted ideas of how galaxies are created.

Peter Quinn made his discoveries during research for a Ph.D. in astronomy at ANU's Mount Stromlo and Siding Spring Observatories. His basic conclusion is that one type of galaxy changes into another.

The astronomical puzzle Quinn solved involved faint arc-like arrangements known as shells. These were first discovered 18 months ago by astronomers David Malin and Dr. David Carter of the Anglo-Australian Observatory at Siding Spring.

They used advanced photographic enhancing techniques and a 4-meter telescope to detect the shells, very faint astronomical phenomena that do not show up visually. According to Quinn, the shells are only present in elliptical or spherical shaped galaxies. Flat spiral galaxies such as the Milky Way do not have them.

Since the AAO discovery of the shells, astronomers have unsuccessfully tried to explain their existence. There have been many theories about the shapes of spiral and elliptical galaxies, but none so far has become accepted.

Quinn's research tool was a computer modeling technique. With it he showed that elliptical galaxies and the peculiar shell-like star layers within some of them were the result of collisions between spiral galaxies.

His calculations involved putting into the computer essential dynamic characteristics of spiral and elliptical galaxies such as shape, internal mass distribution, and velocities of the component stars. He simulated collisions between spiral galaxies, elliptical galaxies and spirals and ellipticals.

The collisions between spiral galaxies resulted in the formations of distinctive shell-like shapes surrounding the outer edges of the computer images — reflecting the photographic evidence. Also, the original flat spiral galaxies changed in shape to either spherical or elliptical, again confirming the photographic observations made by Malin and Carter.

Quinn theorizes that the shell-like layers of stars in elliptical galaxies are stars thrown out from the flat spiral galaxies as they collided. The shells were hurled into space, similar to the leading edge of a wave as it breaks on the shore.

The shell layers of stars continued on their outward path away from the center of the galaxy. Those shells observed in elliptical galaxies were located at immense distances from the galactic center and retained only a very loose relationship to it. The central cores of the colliding galaxies gravitationally captured each other and eventually formed a new elliptical galaxy with faint shells at vast distances from its center.

Quinn further explains that these galaxies retained their outer shells until another collision occurred. The shells were then disturbed and the elliptical galaxies lost the features that distinguished them from others.

According to Quinn, about 10% of the elliptical galaxies in the universe still show outer layers of stars and these galaxies are usually isolated from other galactic systems. The elliptical galaxies without shells were generally grouped with other galaxies and, through interaction with them, have lost this characteristic.

Quinn's conclusion is that one type of galaxy changes into another, and that flat spiral galaxies are the basic building blocks of the universe, although some collide with others to form elliptical galaxies in which shell features are an intermediate stage of galactic development.

Quinn believes his evidence proves that the elliptical shape represents a more advanced form of galaxy development than spirals. It also supports the growing belief among astronomers that collisions between galaxies are a normal occurrence and happen fairly regularly.

The collision of NGC-4038 and NGC-4039 will eventually form an elliptical galaxy if the latest theory on galactic evolution is correct. Photograph courtesy Kitt Peak National Observatory.

Natural Laser Discovered on Mars Could Alter Theories

Investigators at NASA's Goddard Space Flight Center and the University of Maryland have discovered a natural infrared laser on Mars — an observation that could lead to the discovery of new planets in the universe and might force scientists to revise current theories on the general physics of the planetary atmosphere.

The discovery, reported in *Science*, was made by Michael J. Mumma, David Buhl, Gordon Chin, Drake Deming, Fred Espenak, Thodore Kostiuk, and David Zipoy.

"Despite this somewhat deceiving abundance of man-made lasers," they reported, "no naturally-occuring lasers have ever been reported, even though the extreme variety of physical and chemical environments of extraterrestrial objects plausibly argues that natural lasers must exist."

In theory, lasers occur when atoms or molecules are stimulated to release photons during their transition from higher-energy to lower-energy states.

This process was detected in the martian atmosphere between January and April 1980, through the use of the newly developed infrared heterodyne spectrometer and the Kitt Peak McMath Solar Telescope in Arizona.

The natural laser is identical in physical principle to man-made carbon dioxide lasers used for commercial, scientific and military purposes here on Earth.

The total power output of the Mars laser, however, exceeds one million megawatts — equivalent to that generated by about 1,000 large hydroelectric power projects. Eventually, it may be possible to extract power from the natural laser and beam it to wherever it is needed.

Pioneer Probes Charting Wind Circulation on Venus

The Pioneer Venus spacecraft, four entry probes and one orbiter, arrived at Venus in December 1978. Since then, they have produced results which show that the predominant weather pattern on Venus is a circulation of the middle and upper atmosphere that moves around the planet from east to west at speeds of up to 360 kilometers per hour.

Superimposed on these high-velocity movements are lower-speed winds that blow north and south from the equator toward the poles. Wind and temperature measurements show that these make up a series of equator-to-pole circulation cells, stacked one on top of the other with each of the upper three cells counter-rotating as gears do.

The winds in these equator-to-pole circulation loops are driven by the solar energy absorbed primarily in the planet's dense, high-cloud layer. The cells carry heat, absorbed near the equator (where sunlight falls almost vertically), into the polar regions. Because Venus' rotation is slow, the huge loops do not break up as do similar loops in the Earth's atmosphere.

These two directions of wind circulation — east/west and north/south — keep the atmosphere of Venus well-mixed. There is little difference in pressure or temperature no matter where it is measured, and Venus' night is as searingly hot (600 K) as its noontime.

While Venus' atmosphere behaves differently than Earth's, understanding the weather on our "sister planet" helps scientists understand such terrestrial weather phenomena as the greenhouse effect, heat transfer to polar regions, and mixing between the lower atmosphere and the stratosphere.

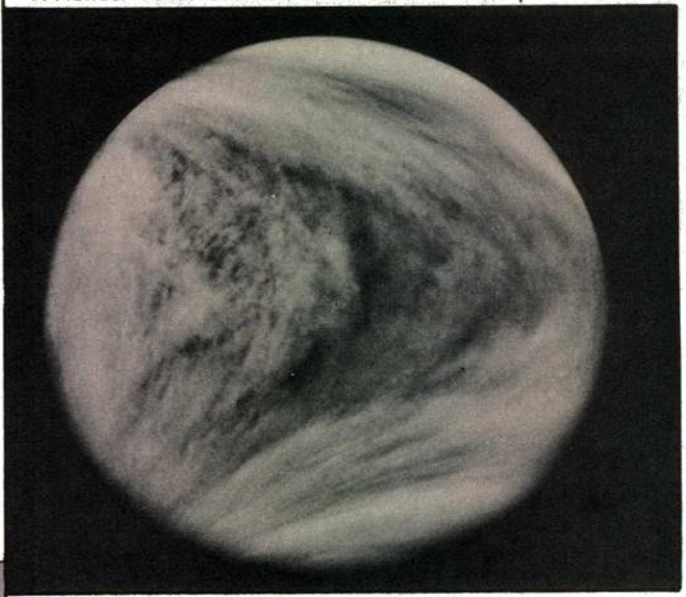
The venusian winds represent 25 times as much mass as the total Earth's atmosphere, but amount to just a quarter of Venus' enormously massive atmosphere — 100 times that of Earth. At their fastest, the winds circle Venus once every four days.

Despite the velocity and amount of the high-speed, upper-level winds, the lower three-fourths of the venusian atmosphere is very sluggish. Up to a 10 kilometer altitude, the maximum wind speed is only about 20 kilometers an hour.

The high wind speeds in the uppermost layers come about when venusian "air," warmed by the Sun, rises and carries aloft some of the momentum from the solid planet. As the atmosphere circulates, the momentum begins to accumulate at high levels over several cycles.

The wind in the top half of the north/south circulation cells flows toward the poles; on the bottom, it flows toward the equator. Air is warmed at the equator, rises, and spills over toward the poles. There it cools slightly, begins to sink, and flows back to the equator to start the process once again.

A Pioneer-Venus Orbiter view of Venus. NASA photo.



Index

- New Theory on Galactic Evolution
- Natural Laser Discovered on Mars
- Pioneer Charts Winds of Venus
- Jupiter's Magnetotail Found at Saturn
- Satellites Monitor California Crops

Shuttle Notes

- NASA Studies Orbital Assembly
- Space Hardware Recycled
- Shuttle and Satellite to Troll Atmosphere

Tail of Jupiter Found "Downstream" at Saturn

Heading for its rendezvous with Saturn in August 1981, Voyager 2 encountered the magnetic tail of Jupiter extending almost 300 million miles beyond the giant planet — and the end isn't yet in sight.

Scientists detected noises in plasma wave measurements obtained on February 1981 that were similar to those last heard in July and August 1979, when Voyager 2 was departing Jupiter but still in that planet's magnetosphere. From this new information, they determined that Voyager 2 passed through a filament of the jovian magnetotail a year and half after leaving the planet.

As Voyager moved toward its meeting with Saturn, both

Saturn and the spacecraft crossed into the jovian magnetotail, or wake, about 390 million miles beyond Jupiter. This alignment of Saturn in the expected region of Jupiter's tail happens only once every 13 years, and Voyager 2 was in a nearly perfect position to investigate the phenomenon.

Jupiter's magnetosphere, like Earth's, is shaped like a teardrop, but its size is enormous compared to Earth's. As the solar wind streams past the planet, it blows the huge magnetic globe into a tail that points away from the Sun.

Several years ago, Dr. Frederick Scarf, principal investigator of Voyager's plasma wave instruments, suggested that Jupiter's magnetotail might extend all the way to Saturn. He pointed out that the rare outer-planet alignment that made the multi-planet mission possible would also lead to a nearly simultaneous alignment of Voyager 2 and Saturn in Jupiter's tail.

Dr. Scarf published his ideas in the *Journal of Geophysical Research* in 1979, before Pioneer 11 made the historic first visit to Saturn and confirmed the existence of a saturnian magnetosphere. He predicted that "Voyager 2 may remain in the Jupiter magnetosheath-bow shock region for an extended time and the spacecraft may well interact with the distant tail in 1981. Saturn itself may be immersed in the tail of Jupiter during comparable periods in 1981."

"The way we tell we're in the tail," Scarf explains, "is that we see noise in a certain range of frequencies that is characteristic of Jupiter. In data we received from Voyager earlier this year, we saw exactly the same characteristics we saw when we left Jupiter a year and half before. We are convinced that we have experienced Jupiter's magnetosphere again."

Scarf contacted Dr. Herbert Bridge and Dr. James Sullivan of MIT, scientists on the Voyager plasma probe who measure plasma streams from the Sun that form the solar wind. They told him they had not seen any solar plasma during that part of February — that the solar wind did not flow past the spacecraft then. This confirmed Voyager 2 was in the jovian tail for at least those few days in February.

"We now know that Jupiter, the Earth, and comets have extremely long magnetic tails," said Scarf, "caused by the solar winds stretching their magnetic fields out over enormous distances. A comet's tail is luminous and can be seen. Jupiter's tail is not. The only way we can be certain that planetary tails exist is to measure the absence of solar wind plasma and the presence of trapped radio waves.

"The magnetotail is like a magnetic hole in which the solar wind doesn't blow. It's affected by the orbital movement of the planet and the ebb and flow of the solar wind, and appears to flap or wag back and forth, with lots of filaments like loose hairs waving in the breeze.

"We're interested in understanding the energy that is stored in this region. We don't understand any of the processes that go on in a distant magnetotail. Comet tails flare up, and some scientists speculate that energy is stored in the tail and then returns to produce an aurora. We imagine similar things happen at Jupiter (or even in the distant tail of Earth), but we haven't yet explored those regions — we only know that there's an interaction between the tail and its planetary body that should be explored.

"Some of the planetary plasma that is blown out in the tail could be recirculated by returning through the tail and affecting Jupiter. Energy accumulates in the tail region and a storm can develop internally — generally called a substorm. At such times, the stored energy will flare up, explode, and return to the planet," concludes Scarf.

Satellites Help to Monitor California Crop Progress

Governor Brown is no doubt pleased with the fact that California agriculture is now being monitored from space. NASA's Ames Research Center and the California Department of Water Resources are testing the use of satellite imagery to inventory and map irrigated cropland.

During July and August, anything that shows up red on Landsat color composite images indicates vigorous vegetation and may have been irrigated.

Irrigated areas are differentiated from natural vegetation by their spatial rather than spectral characteristics. Irrigated fields show distinctive shapes (usually blocked) and homogeneous texture as opposed to the irregular shapes of natural vegetation and the mottled appearance of forests.

NASA's two Landsat satellites can survey any spot on Earth every 18 days. A multi-spectral scanner on each satellite records differences in Sun reflectance from Earth's surface features.

The scanner takes four readings for each 1.1 acre area on the ground, based on the intensity of reflected visible and infrared light. These intensity levels are converted to film and computer tapes.

Maps indicating irrigated areas are drawn from the satellite data. Since agriculture uses 85 percent of California's water supply, such maps help monitor water use.

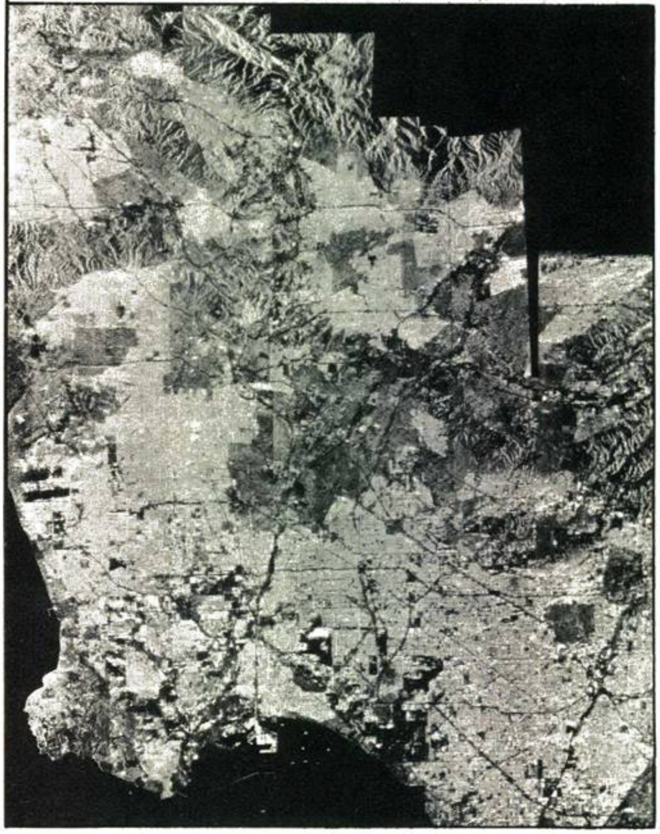
Landsat does more than confirm existing data. The satellite imagery is used for monitoring early grains and double cropping.

Certain crops have a Landsat signature, determined by viewing the same area over a given time, that shows the distinctive coloring or spectral reflectance that separates one crop from another. For example, in the early part of the year, alfalfa and wheat both appear red, but in late May or June, the wheat has dried and appears bright yellow. Irrigated alfalfa keeps its red appearance on the satellite imagery.

More than 10 million acres were surveyed by the satellite, and 1.25 million acres of ground-sample data acquired by the California Department of Water Resources were used to verify the satellites' information.

Landsat orbits the earth 14 times each day at an altitude of about 570 miles. The first Landsat was launched in 1972 and, though only expected to function one year, continued to provide information until January 1978. Landsat-2, still functioning, was launched in January 1975; Landsat-3 was put into orbit March 1978. A fourth and more technically advanced Landsat is scheduled for launch in 1983 and could operate well in to the '80s.

The greater Los Angeles area from a Landsat satellite. NASA/JPL



Shuttle Notes

NASA Researchers Study Orbital Assembly Line

An "assembly line in space" that would allow astronauts to construct large platforms or antennas in Earth orbit while using the Space Shuttle as a construction site is being studied at NASA's Langley Research Center in Hampton, Virginia.

The concept calls for a mobile work station to position a pair of pressure-suited astronauts so they can move horizontally and vertically within a prescribed area to build space systems that are too large or complex to fold up and transport aboard the Shuttle. The work station would be located inside the Shuttle Orbiter's payload bay or be a free flyer, operating near the Orbiter.

A large-scale experimental model of the mobile work station is being tested at Langley. The ground test model will enable researchers to uncover difficulties that might be encountered in space.

The astronaut work platforms, one on each side of the mobile station, would be electrically operated either from the platform or from within the Orbiter's flight deck. Two astronauts would be attached to the station by foot restraints, freeing their hands for assembly tasks, and enabling them to move around and build large platforms without expending great effort.

The horizontal and vertical freedom of movement will allow the astronaut team to put together elements of a structure with relative ease. When a section of a structure is completed, it will be moved along the assembly line and the astronauts will extend its size by adding more elements or equipment.

Recycling Space Hardware Stretches NASA Budget

With today's national interest in economizing and reducing costs, engineers at NASA's Marshall Space Flight Center, Huntsville, Alabama, have examined the solid rocket booster recovery parachutes from the first Space Shuttle mission and evaluated them for reuse in later missions.

On their maiden flight, the chutes sustained reparable damages, including tears, scorches, stains and burns.

Some of the staining — orange in color — is rust from the water used to wash the parachutes after recovery. Other stains, dark and tar-like, are still being analyzed, but engineers believe them to be by-products from burned insulation exiting from the nozzle.

Hot exhaust scorched and burned parts of the chutes and these will be patched — as will some torn parts. After repair, the parachutes will be used on the fourth Shuttle flight, and engineers expect them to meet or exceed their design-lifetime of 10 missions.

NASA's budget will also benefit from the recycling of special fans, used during the late 1960s and 1970s to provide ventilation inside the Apollo Command Module after splashdown, and to circulate air aboard Skylab, launched in 1973. The fans have been on display at the Smithsonian Institution, but were returned to NASA recently for use on future missions.

Technicians removed most of the fans from the back-up Skylab on display at the Smithsonian's National Air and Space Museum and returned them to Huntsville for recertification. Of the 35 fans tested, 25 will be usable for up to 10 flights each aboard the Space Shuttle. Some of the old Skylab fans will be used in the Earth-orbiting laboratory, Spacelab.

One will circulate air in the Spacelab transfer tunnel, the passage linking the Shuttle Orbiter's mid-deck with the Spacelab habitable module; another will serve as a flight spare. Two other fans were used in a cosmic-ray experiment flown on the second Spacelab mission. In all, 13 fans have already been programmed for use.

These are no ordinary household fans: they use a specially designed high-efficiency DC motor that works without brushes (to prevent sparking), and they were manufactured from special materials under very stringent controls. If purchased today, these fans would cost more than $22,000 each. NASA re-use programs could save up to $1,000,000.

The Shuttle's solid rocket booster parachutes will be repaired and reused to help stretch the NASA budget. NASA photo.

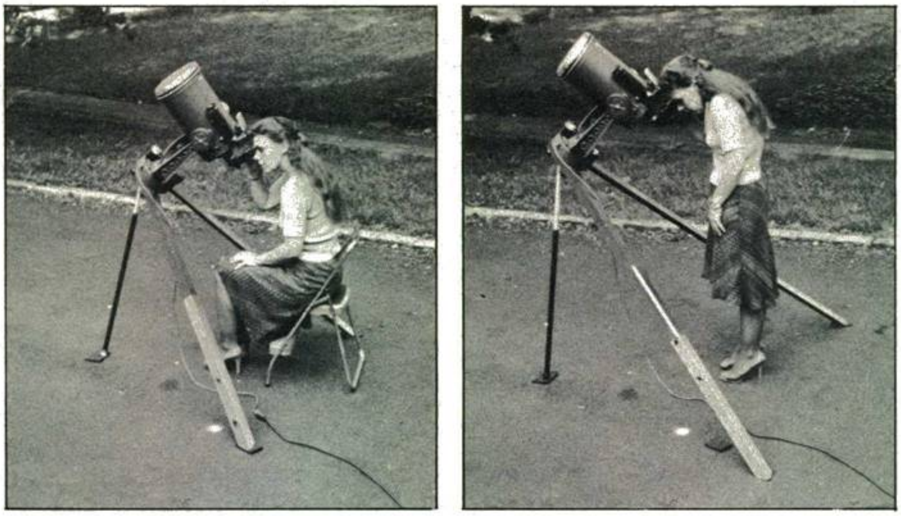
Space Shuttle to Troll Upper Atmosphere with New Satellite

A series of meetings which may bring the U.S. and Italy a step closer to a joint space effort were held recently at NASA's Marshall Space Flight Center in Huntsville, Alabama.

During those two days, engineers from the Marshall Center and Italian space officials discussed recent studies of NASA's proposed Tethered Satellite System. This project calls for a data-gathering satellite to be carried into orbit by the space shuttle, then released from the payload bay on a tether — a super-strong cord that can be as long as 60 miles. The satellite will be trolled through the Earth's upper atmosphere to gather atmospheric, magnetospheric and gravitational data.

The Italian scientific community first became interested in participating in the tethered satellite project about a year ago, following the review of a study by Marshall engineers and aerospace contractors. Since that first meeting with the Italians, NASA has proposed that a cooperative effort may be possible. "If such a joint venture were to be undertaken," said Jay Laue, an engineer in the Marshall Center's Advanced Systems Office and manager of the tethered satellite study team, "the Italians would build the satellite and the U.S. would build the deployer and handle the systems integration." The deployer is the boom and related apparatus that fit inside the Shuttle's cargo bay.

Unlike sounding rockets which remain in the atmosphere for only a few minutes, or the low-altitude non-propulsive satellites which gather data for only a few hours before their orbits decay, the tethered satellite can be pulled through its extremely low orbit — perhaps only 80 miles above the Earth — for an extended period.



Low-Cost, vibration-free, adjustable-height, combination wedge and tripod for Celestron, Dynamax or Meade scopes.

SOME REASONS WHY YOU SHOULD MAKE US YOUR FAVORITE CELESTRON TELESCOPE DEALER

- We think our customers are just as honest as we are so we accept personal checks and ship scopes immediately from our large stock without waiting for the checks to clear. Our friends think we are crazy but we feel that a reputable mail order business should be based on trust. You trust us so why should we not trust you? We give you personal service both before and after you order.
- We resist selling you what you ask for if we feel it not appropriate for your current skills. We specialize in helping beginners choose the correct equipment and accessories.
- You do not have to buy from us to get the benefit of our experience and valued judgement on things astronomical.
- We are available. Who else can you call late at night to order a part or get the coordinates of a planet?
- We know the Celestron line almost as well as the manufacturer since we have units in daily use personally.
- We have a convenient lay-away plan.
- We know the strong and weak points of all commercial scopes and are willing to tell you what they are. Maybe some other scope than a Celestron is best for you — if so we will tell you.
- We have developed a line of Custom Engineered accessories for Celestron and other fine scopes that enhance the operation of these beautiful instruments. EVERY Celestron Telescope would operate with less hassle when fitted with these unique accessories. NO GIMMICKS — all made to help the beginner. Many of these valuable Custom Engineered Accessories are available FREE in our SUPER CELESTRON PACKAGE.

DON'T BE AFRAID — Our Mail Order shipments to any place in the world are shipped in special containers. If by remote chance the scope arrives damaged, we ship you a new one and WE handle the claim with the shipper — YOU don't. In addition we give you our unique lifetime guarantee on the C-8 motors. **WE EXPORT SCOPES WITH ANY VOLTAGE AND FREQUENCY FOR EITHER HEMISPHERE.**

Do you feel in need of an astronomical friend? Call me. I would be glad to help you. I love astronomy and wish everyone did.

Roger W. Tuthill

Send a LARGE (8½" x 11") BROWN Self-Addressed Stamped Envelope (2 oz.)
Our new FREE catalog which illustrates all our unique aids to your great hobby:

Call us for the strong points of Dynamax, Meade, Questar, Quantum and Celestron Scopes.

Send for our surplus list

WE REPAIR CELESTRON SCOPES

Telephone: 201-232-1786
(N.Y.) 212-926-6498
(L.I.) 516-794-2050

Master Charge, VISA
*Trade Mark

ROGER W. TUTHILL, INC. **Box 1086A, 11 Tanglewood Lane, Mountainside, N.J. 07092**

SOME OF THE GREAT ACCESSORIES LISTED IN OUR CATALOG TO ENHANCE YOUR ENJOYMENT OF THIS SPACE AGE HOBBY

- **SOLAR SKREEN SUN FILTERS:** The fine qualities of the SAFETY of this patented filter are described in detail by Dr. B.R. Chou in "Sky and Telescope" August 1981. Fits all scopes without glue or magnets.
- **GIANT FINDERS:** All scopes deserve a good finder. Ours are 50mm or 80mm in diameter — take standard 1¼" eyepieces and are convertable — right angle or straight thru. Wide sharp fields of view.
- **PRECISION CELESTIAL ALIGNMENT UNITS:** Our unit adaptable to nearly all types of mounts — aligns the mount not the scope — for perfect polar alignment in moments. Takes all the guess-work and hassle out of this chore. Recognized by USA issued patent #4,260,253.
- **SUPER LIGHT-WEIGHT, VIBRATION-FREE, ADJUSTABLE-HEIGHT WEDGE AND TRIPOD UNITS:** This device has an I.Q. of ONE second. (See Sky and Tel. pg 564 June '81.) The ultimate in an equatorial support for Meade, Dynamax and Celestron units.
- **NO DU CAPS HEATED OR UNHEATED:** These units give the best dew resistance for constant protection in very tough conditions.
- **DRIVE CORRECTORS AND AUTOMATIC GUIDERS:** For use in photography or off-site operation.
- **FOR CELESTRON SCOPES:** Slow motion RA. controls, Setting Circle lights, Electric focus units, Table-top equatorial mounts, Ball and socket piggy back mounts, Helical focusers, Permanent pier heads. Digital Readouts and computer controlled Celestial Navigators.
- **ATTENTION:** We can convert your Dynamax scope so that it will take all the wide range of Celestron accessories. We also can supply for it and the Meade scopes, No Du caps, Right angle finders, Sun Filters, and permanent pier heads.

Write for a listing of our sale on surplus telescope parts. We sell Edmund Scientific Scopes too.

FREE

JOINT CELESTRON/TUTHILL TELESCOPE— TELEPHOTO LENS SEMINAR — SALE

Saturday, November 14, 1981 9 a.m. to 5 p.m. Continuous at Holiday Inn, Springfiled, NJ

- Instructions on basic optics — Tuthill
- Technical Information on Celestron products by top Celestron factory personnel
- One day bargain prices on scopes, telephoto lenses and accessories.

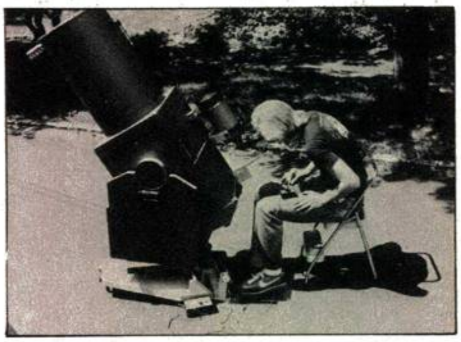
DO YOUR CHRISTMAS SHOPPING EARLY

Celestron 90 spotter telescope door prize. Write for more information.

SEE * HYDROGEN FLAMES ON THE SUN

SEE * VENUS IN THE DAYTIME

TUTHILL ODYSSEY PONCET SYSTEM



The "TOP" System is the **T**UTHILL **O**DYSSEY **P**ONCET Equatorially Mounted Telescope System. It is the renowned Odyssey Newtonian reflector made by Coulter Optical Co., sold by us, mounted in a Tuthill designed unique Poncet Equatorial Mount. (See *Sky & Tel.* Feb. 1980). This system provides about one hour of accurate, smooth, stable, equatorial motion for tracking celestial objects or for guided astrophotography. This NEW "TOP" System is available as 1. Complete plans for the do-it-yourself amateur astronomer or 2. In kit form with the motor and all the hard to get parts and plans with you doing the actual fabrication of the Poncet Mount, or 3. As a complete working unit, which requires the addition of an Odyssey which you may wish to purchase from us since our delivery may be very short. Write for more information.

WE HONOR MASTER CHARGE AND BANKAMERICARD.
MONEY-BACK GUARANTEE ON ALL PRODUCTS WE SELL
Telephone: 201-232-1786 (N.Y.) 212-926-6498 OR (L.I.) 516-794-2050

ROGER W. TUTHILL, INC. Box 1086A, 11 Tanglewood Lane, Mountainside, N.J. 07092

“SHARPEST I’VE EVER USED”

— Richard Berry
Editor, **ASTRONOMY**

HERE’S THE COMPLETE REVIEW FROM THE AUGUST ISSUE OF **ASTRONOMY**

Plössl Eyepiece Set
7.4, 10.4, 17, and 26mm EFL
eyepieces in 1¼" barrels
$55 each
Tele-Vue Optics, Inc.

“An eyepiece is an eyepiece — why spend any more than you have to on them?” said a friend of mine when I mentioned I had just purchased a set of Tele-Vue eyepieces. Certainly at $55 each, the price is enough to make anyone stop and think twice. But I am satisfied because the Tele-Vue Plössls are the sharpest I’ve ever used.

For years I’ve gotten along with a pretty ratty set of eyepieces, some that I bought 20 years ago, some that came with various telescopes, and a big Erfle I bought a few years ago. I’ve looked at, and been tempted by, newer ones, but whenever I’ve compared them at ATM meetings, I haven’t seen any that gave sharper images than those I already own.

The Plössls arrived looking beautiful. Nothing was loose; nothing rattled or shook. They were extremely clean and dust-free. For a quick check, I tried all four in my Astroscan — then I knew I had something good! Even with the f/4.5 optical system of the Astroscan, the images were crisp and sharp nearly to the edges of the field. When I focused, the image seemed to “snap” at the moment of best focus instead of mushing through focus as do many eyepieces used on a fast optical system.

I frequently use the Astroscan for projecting the solar image. My trusty old 28mm Kellner eyepiece does a terrible job — the image is mushy and has color fringes. The 28mm RKE is a vast improvement — but it still is a bit soft through focus and some detail is lost. The 26mm Plössl does a superb job — tiny low-contrast details in sunspot penumbrae stand out sharply.

Used with my 12" f/7 telescope, the Plössls deliver crisp images of the planets. I have the distinct impression that the eyepiece adds no optical errors to the image I’m viewing, and that I am seeing everything the mirror can deliver. This is an impression I’ve never had with any other eyepiece.

Tele-Vue’s Plössls also look handsome. They are quite heavy, feel solid, and possess details of fine workmanship. Their shape fits my eye quite comfortably. Although the 26mm can be used with glasses on, I must remove mine to use the others. Without glasses on, I must refocus slightly when I switch from one eyepiece to another. One slight note of caution: the barrels of these eyepieces are *exactly* 1.250" in diameter. Since one focuser I own is undersize by several thousandths of an inch, the Plössls do not fit it properly. If you buy these eyepieces, you may also have to upgrade your focuser.

Are these eyepieces worth their price? If you are using a slow optical system, most eyepieces will give you a satisfactory image. With fast optics, however, I haven’t seen anything to match them.

Richard Berry.

- **NEW 4 ELEMENT PLÖSSL DESIGN**
- **MULTI-COATED • WIDE 50° FIELD**
- **PARFOCAL • THREADED 1¼" BARRELS**
- **7.4mm, 10.4mm, 17mm, 26mm EFL**

$55. EA PPD (USA)

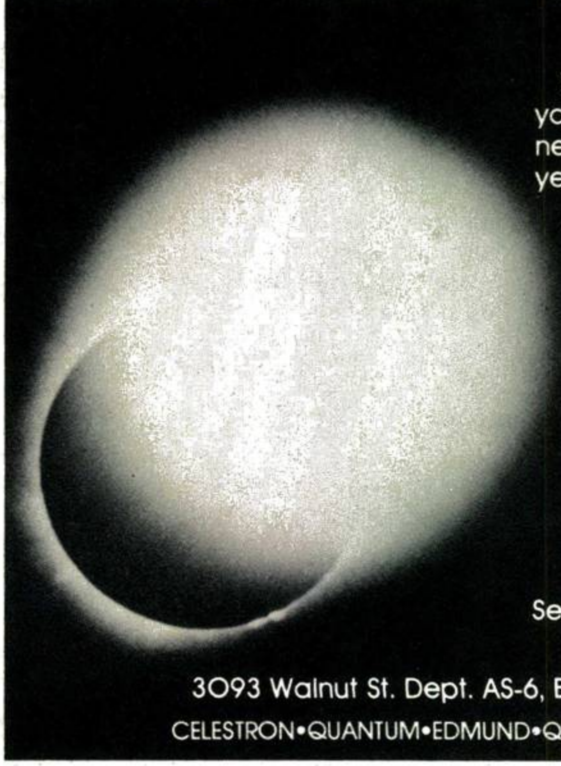
YOUR SATISFACTION IS
GUARANTEED, OF COURSE

Tele Vue™

15-A GREEN HILL LANE,
SPRING VALLEY, NY 10977
PH. 914-354-4262

STAR TRACKER

“We’re the best”



We at Star Tracker believe we are the best, and we want you to know it. Our professional staff is ready to meet your needs with the finest astronomical equipment, backed with years of “hands on” experience.

We stock a full line of major brand telescopes, making it possible to test and compare each instruments performance.

If you are unable to visit us, write for our catalogue. In addition to our merchandise, our catalogue includes; an explanation of eyepiece optics, telescope selection guides and optical maintenance procedures.

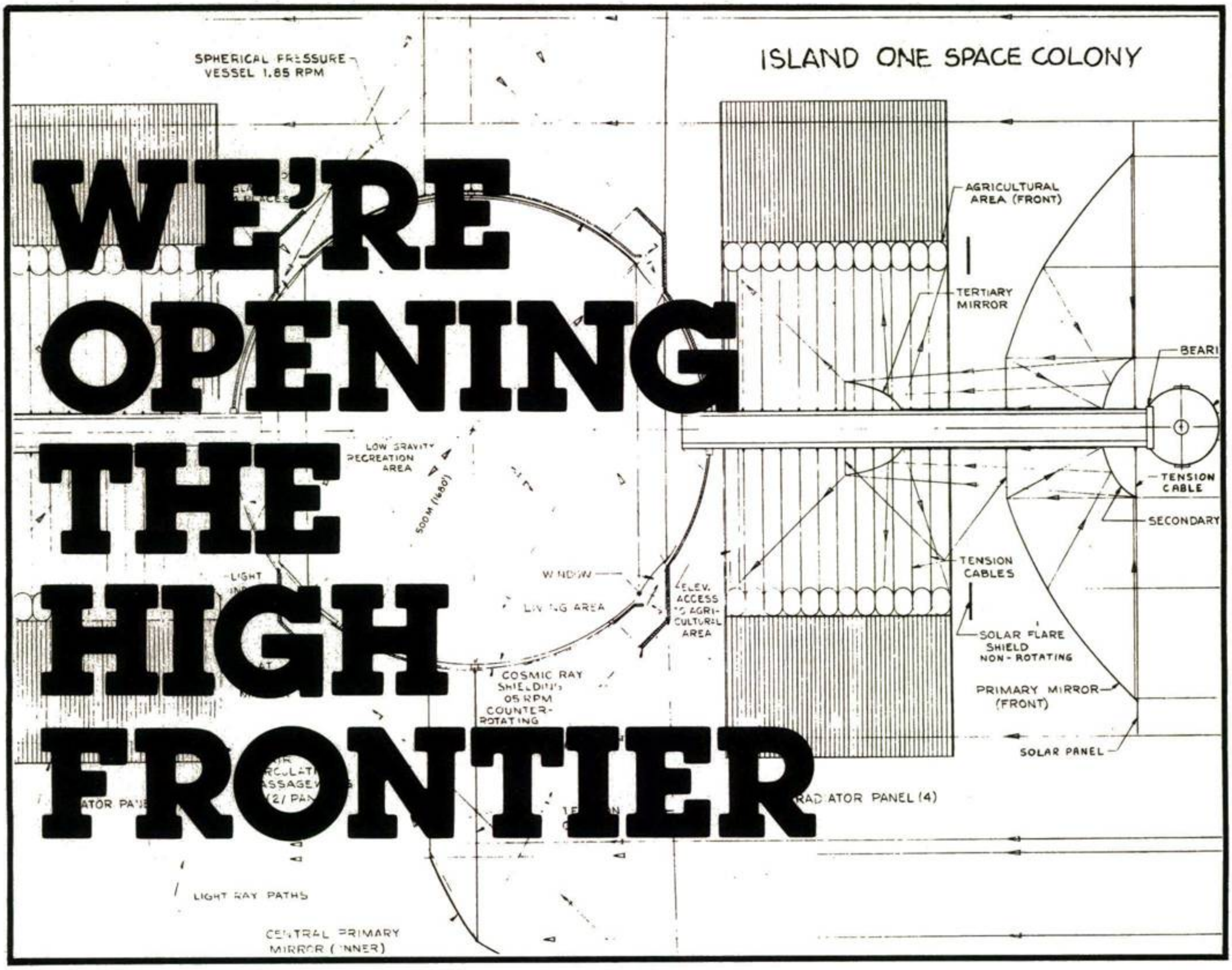
Whether you’re just beginning to explore, or have been viewing the stars for years, we’re dedicated to bringing the heavens into your backyard, we’re the best.

Send $2.00 for your catalogue today!
(Allow 4-6 weeks for delivery)

3093 Walnut St. Dept. AS-6, Boulder, CO. 80301 (303) 442-6805

STAR TRACKER

CELESTRON•QUANTUM•EDMUND•QUESTAR•MEADE•STAR•UNITRON•PENTAX


WE'RE OPENING THE HIGH FRONTIER
ISLAND ONE SPACE COLONY
SPHERICAL PRESSURE VESSEL 1.85 RPM
AGRICULTURAL AREA (FRONT)
TERTIARY MIRROR
LOW GRAVITY RECREATION AREA
500M (1600')
TENSION CABLE
SECONDARY
WINDOW
LIVING AREA
ELEV. ACCESS TO AGRICULTURAL AREA
TENSION CABLES
SOLAR FLARE SHIELD NON-ROTATING
COSMIC RAY SHIELDING .05 RPM COUNTER-ROTATING
PRIMARY MIRROR (FRONT)
SOLAR PANEL
RADIATOR PANEL (4)
LIGHT RAY PATHS
CENTRAL PRIMARY MIRROR (INNER)

JOIN US

The Space Studies Institute is a non-profit corporation established in 1977 by Dr. Gerard K. O'Neill, Professor of Physics at Princeton University and author of **The High Frontier** and **2081**.

The primary goal of the Institute is to conduct and support the leading edge research essential to opening the resources of space for human benefit within this century.

The Institute is presently funding research in three technical areas. Each is critical to the use of nonterrestrial resources, or offers high payoff in reducing investment costs and speeding returns: the mass driver, separation chemistry, and design studies of industrial systems and habitats in space.

In order to maintain its independence and therefore its ability to carry out research on a logical, continuing basis unaffected by politics, the Space Studies Institute draws its main support from a large number of individual donations. SSI carefully monitors the research it funds, and continues grants on the criterion of accurate, demonstrable results.

Support for SSI includes donations given annually by Subscribers, and on a five-year pledge basis by Senior Associates. All are tax-deductible, and SSI sends a quarterly newsletter to its supporters throughout the world.

Join us. Support the research that is opening the High Frontier of space for the benefit of all citizens of Planet Earth. Clip the coupon and send it with your check or money order in U.S. funds today.

Space Studies Institute
195 Nassau Street
P.O. Box 82
Princeton, N.J. 08540
(609) 921-0377

I wish to support the research and educational programs of the Space Studies Institute for one year as a:

- ☐ Sponsor ($200-$500)
- ☐ Donor ($100)
- ☐ Contributor ($25)
- ☐ Subscriber ($10)

(Includes Quarterly Newsletter)

Enclosed is $__________

Name (please print)

Address

City

State Zip Code

All donations are tax deductible.

Space Studies Institute
P.O. Box 82, Dept. A
Princeton, New Jersey 08540
Dr. Gerard K. O'Neill, President

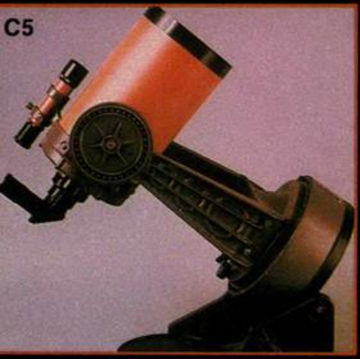
Celestron® Astronomical Telescopes

Celestron offers the world's largest assortment of modern telescopes, and a complete accessory line is available so that these telescopes can expand in capability with your interest. Celestron's quality in optics, mechanics, customer service, detailed operating instructions, dealer network and more have made Celestron the world's best-selling modern telescope brand. Come explore the universe and your creative potential with a Celestron.

C90

• C90 Astro Telescope

The smallest Celestron (only 13" tall) with a motorized clock drive, the C90 is 90mm or 3½" in diameter. It can be used as a 1000mm telephoto. With it you'll be able to study lunar craters, the rings of Saturn, the cloud belts and moons of Jupiter, and scores of nebulae and galaxies. During the day you'll see bees buzzing in flowers 20 feet away, observe birds feeding their young in nests 50 feet away, identify airliners miles away, and much more. The C90 is much more than just a quality astronomical telescope. It's also the ideal telescope for birdwatching, wildlife/nature viewing, or general spotting. Three versions: a telephoto, a spotting scope and an astro telescope (shown) are available.


C5

• C5

While there is no substitute for the brilliance, detail and clarity of image offered by a well-made, optically large telescope, extreme portability is sometimes as much a factor in selecting a telescope as is larger-aperture performance. The 5-inch diameter, C5, offers extreme portability at an aperture large enough for serious astronomical observing and photography. Weighing in at a mere 13 pounds, this 300-power telescope is as portable as your briefcase and as easy to use. It is also a remarkably versatile telescope—being a daytime telescope, a 25x telephoto lens, an astronomical tabletop observatory and a deep-space camera all in one instrument. This is the ideal telescope for nature enthusiasts, telephotographers and amateur astronomers. This is the smallest Celestron we recommend for deep sky photography.

C8

• C8

Here, at last, is a large-aperture telescope designed for the modern user: it is really portable, easy-to-use and incredibly versatile. Today, the Celestron 8 is the world's best-selling 8-inch telescope. Though it tips the scales at only 21 pounds (the world's lightest 8-inch scope!) and takes up less room than a suitcase, this 480x telescope more than delivers the optical quality so essential for high performance. And not only is the C8 the superior astronomical instrument its reputation suggests, it is also the ultimate daytime telescope and 40x telephoto lens. The C8 is the recommended telescope for the serious beginner in astronomy. Why? Simply because it is the best combination of portability with enough aperture and focal length to really show detail in most astronomical objects. The best value also!

C11

• C11

The C11 is priced and sized for individuals who want to seriously explore astronomy to an extent beyond the limits of the C8. It is a tremendous leap in performance over the C8. Now more detail will be visible in all astronomical subjects and the worm gear and rugged aluminum sand castings make it very stable for astrophotography. It's also a 2800mm telephoto!

C14

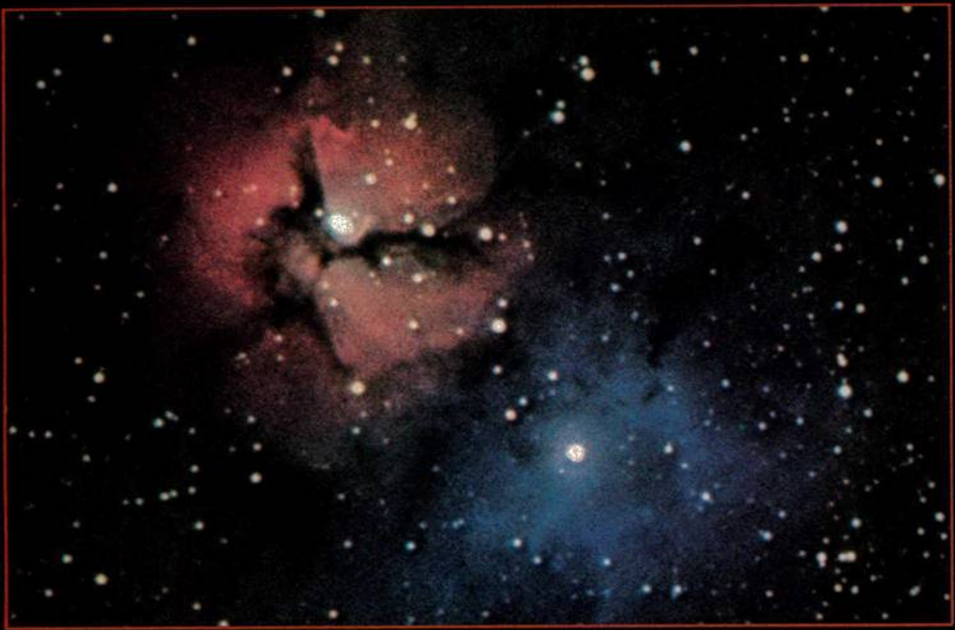
• C14

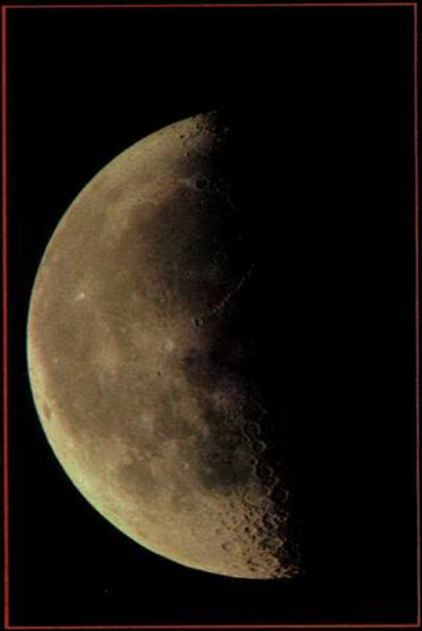
This is the world's largest one-man-portable observatory telescope. As an astronomical telescope, the Celestron 14, with 2,580 times the light-gathering power of the human eye, is a superior instrument indeed—whether for lunar, planetary, or deep-sky observations. And the prestige of the instrument is enhanced by such amenities as a control panel and electrical slow-motions in both axes. It is owned by individuals around the world who want the best.

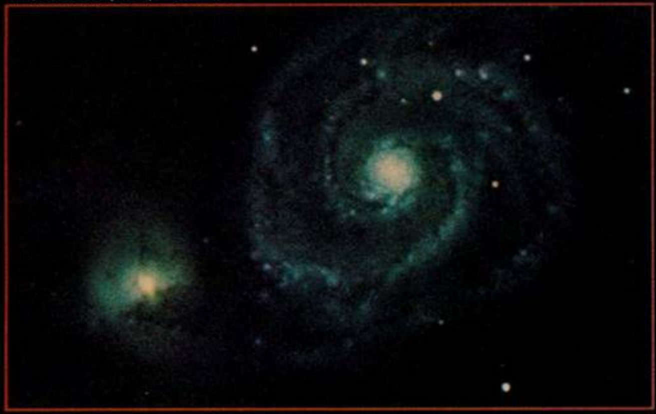
Would you like more information? Our general 52-page color catalog is available for $3.00. In addition, for complete data on all our products, functions, and usages, you may wish to purchase the detailed operating manuals below: **300mm Telephoto—$0.50, 500mm Telephoto—$1.00, 750/1250mm Telephotos—$1.00, Binoculars—$0.50, C90 Instruments—$1.00, C5/C8 Telescope—$1.00, C11/C14 Telescope—$1.00, Schmidt Camera—$1.00**

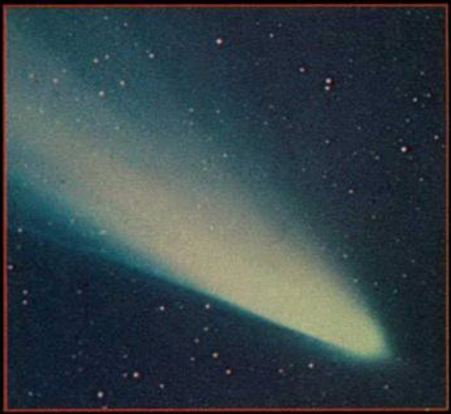
Celestron International, 2835 Columbia St. - Box 3578-B, Torrance, CA. 90503 (213) 328-9560

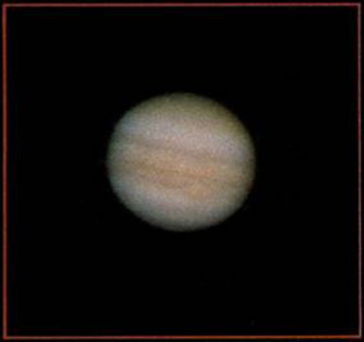
and Astrophotographs You can take with a Celestron®

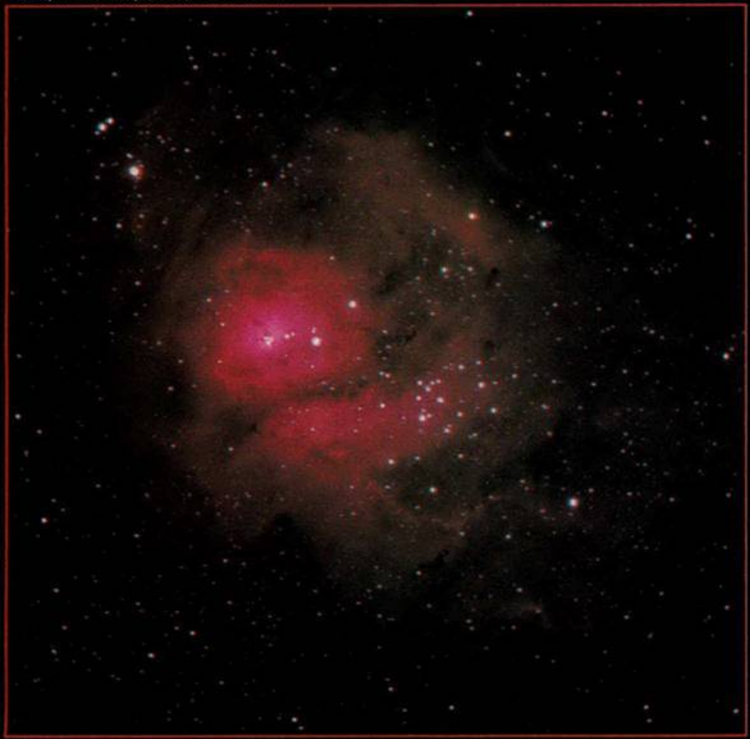

Trifid Nebula (M20)—C8 Photo

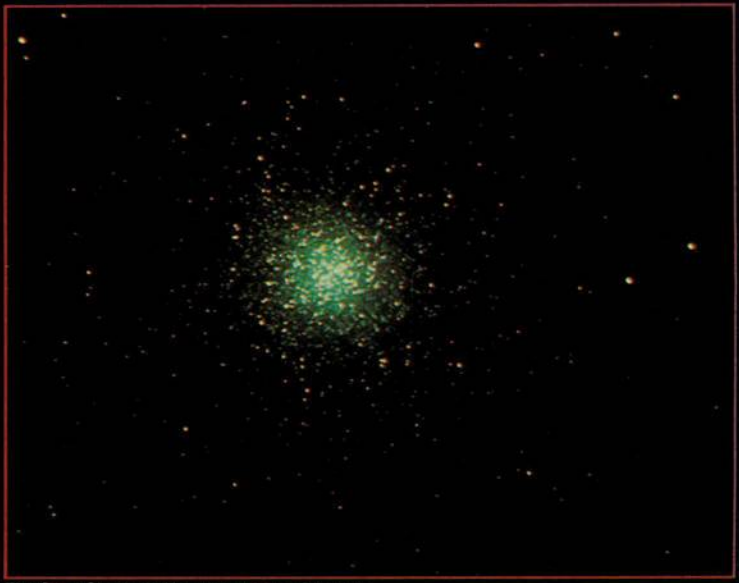

Moon—C11 Photo


The Spiral Galaxy (M51)—C14 Photo


Comet West—5½" Schmidt Camera Photo


Jupiter—C14 Photo


Lagoon Nebula (M8)—C11 Photo


The Great Cluster in Hercules (M13)—C8 Photo

ASTRONOMY
REVIEWS

Orbiting the Sun
Fred L. Whipple
338 pages, hardcover, $20.00
Harvard University Press, (1981)

Orbiting the Sun is the fourth edition of *Earth, Moon and Planets,* which was first published in 1941. Although this latest edition contains some updated information about the planets and the structure of our solar system, it is a far from current guide to planetary astronomy.

Whipple starts his tour of the Sun's family by introducing the reader to the individual planets. Unfortunately, this chapter reads very much like its counterpart in the 1941 edition — except for a few injections of space-age jargon. This is the reader's first tip-off that *Orbiting the Sun* is really not a new book, and that it includes little of what we have learned from recent planetary missions. Instead it merely recycles the information found in its three previous editions.

Another annoying problem, evident from the first chapter onward, is Whipple's choice of illustrations. The book contains many outdated pictures — some nearly 40 years old — instead of recent space photographs. Still appearing in this "new" edition are photographs of Comet Whipple-Bernasconi-Kulin (1943), the solar eclipses of 1932 and 1961, a 1966 satellite photo of Earth, and central Africa from Mercury Atlas 4 (early 1960s).

A lot of the lunar and planetary photos even look old — poor resolution, high grain, fuzziness — and do not represent the best Earth-based photos available today. Some recent space probe photos are included — Mercury, Venus, Mars, Jupiter, and Saturn — but they are outnumbered by the dated material.

Chapter 2, "How the System Holds Together," is the most informative and worthwhile of the whole book. It discusses celestial and planetary mechanics, and the laws of Newton and Kepler. The author does a good job of explaining the natural rhythm of the planets in their motions around the Sun.

Next comes a curious and rather out-of-place section on the discoveries of Neptune and Pluto. It is accurate and to the point, but why is it in this book?

The following five chapters — a third of the book — are devoted to the Earth-Moon system. The first two concern the Earth as a planet and as the cradle of life, but could easily be condensed into a single, more meaningful section. And the inclusion of three chapters on a rather ordinary satellite like our Moon amounts to overkill — and a misrepresentation of current planetary science.

Today, planetary studies center on data returned by the Viking, Mariner, Pioneer and Voyager probes, but Whipple seems to have ignored much of this new information when rewriting his book. This is unfortunate because astronomy enthusiasts and the general public could use some help in interpreting what we've discovered about our solar system in the past decade.

The book continues with a chapter examining Pluto, Mercury, and Venus, a chapter on Mars, one about Jupiter, and another about Saturn, Neptune, and Uranus. All four contain a fair amount of information, but none of them adequately explains these bodies and their satellites. And once again, the illustrations are weak, although four pages of color plates from the Voyagers help the Jupiter chapter.

Whipple's brief and tangled journey through the solar system winds down with two chapters: one that discusses the origin of the solar system and another that compares the planets and moons. There is no separate coverage of comets (Whipple's specialty!), meteorites, or asteroids. This void limits the value of the book since these objects are now thought to be important members of the solar system.

You simply can't write about the solar system in 1981 the way you could in 1941. We have learned too many things to be satisfied with a simple updating. The material needs to be re-organized as a whole. Despite its recent imprint, this book is outdated. Shop around and spend your $20 elsewhere. *Dan Koehler.*

Odyssey 1 Telescope
$459.50 (plus $75 crating)
Coulter Optical Co.
Dept. A, Box K
Idyllwild, CA 92349

My viewing location is heavily light-polluted: the Milky Way is always invisible, I have never seen M-33 in any instrument, and the naked eye limit is about magnitude 4. I usually restrict my viewing to nights of greatest transparency and least moonlight and often observe after midnight. Under these conditions, I found the 13.1-inch f/4.5 Odyssey 1 performed surprisingly well.

Jupiter and Saturn showed great detail, and some satellites of Saturn undetectable in a Dynamax 8 were visible. But on the whole, the shorter (59") focal length of the Odyssey 1 (as compared with that of an 8-inch f/10 catadioptric, say) did not do as well on Jupiter and Saturn as a good, high focal ratio lunar and planetary telescope would.

On the other hand, with galactic clusters, the low f-ratio and large aperture of the Odyssey guarantee outstanding viewing. NGC-2158 (the distant companion to M-35) resolved easily, and numerous small clusters showed far better than with a Dynamax 8. The fine performance of the Odyssey has made browsing through the Milky Way my favorite use for it.

The Crab Nebula (M-1) was visible even near Full Moon, though with no details. The Orion Nebula (M-42) was clearly green and had a long trail to the west. I couldn't see the central star in the Ring Nebula (M-57), but the Dumbbell (M-27) displayed some detail. The Lagoon and Trifid Nebulae (M-8 and M-20) revealed considerable features.

Polluted skies limit my viewing of galaxies, but in spring I can find more than 25 of them. M-51 shows off both parts. M-82 has a vertical rift, and M-64's "black-eye" stands out.

Because of their design, Dobsonians are significantly cheaper than other telescopes of the same aperture. Their simple, smooth-working alt-azimuth mountings consist of a tube in a box that turns on a rocker. (Unfortunately, this design also makes them unsuitable for photography.)

Despite its mechanical simplicity, the Odyssey 1 is large and heavy. You often hear Dobsonians called "portable," but be warned that this means transporting a box full of telescope weighing 150 pounds and measuring 60" x 22" x 22". "Movable" may be a better description.

Coulter has cut costs on the instrument by not including a finder and by providing only one eyepiece. Finders are readily available from many manufacturers, although with practice you easily become accustomed to sighting along the side of the box and following objects in the eyepiece by pushing on the tube. I recommend that you use at least two first-class eyepieces with an Odyssey, perhaps the Edmund 28 mm RKE and any 12 mm orthoscopic.

The best feature of a Dobsonian is its rock-solid stability: Nothing disturbs the view — absolutely nothing! I have used a 10-inch Newtonian and an 8-inch catadioptric, and the Odyssey 1 out-performs both at considerable savings. The ease of using a Dobsonian — together with its gratifyingly large aperture — will tempt you to spend more hours viewing the sky.

If my experience is typical, you can expect an eight-week wait after you send your order. Both primary mirror and telescope will then arrive in excellent shape. Coulter responds promptly and courteously to mail and phone queries, too.

Anyone considering the purchase of a large-aperture telescope ought to read the three part article "How to Build a Dobsonian Telescope" (ASTRONOMY, June, July, and August 1980) and then decide whether to build or buy. If you decide to buy, I recommend the Odyssey 1. *James Greenwald.*

The Night Sky

Richard Grossinger
528 pages, hardcover, $16.95
Sierra Club Books (1981)

A meditative ramble that encompasses astrophysics, astrology, UFOs, and pop-cult "stars," this book provides a loose and rather uncritical view of most of western civilization's skylore — fact, fiction, and mixtures of both are all woven together into a not too watertight whole.

The Fermenting Universe

J. McKim Malville
113 pages, paperback, $6.95
Seabury Press (1981)

Subtitled "myths of eternal change," *The Fermenting Universe* describes in simple language the omnipresent role of change in the physical world. The discussion focuses largely on physics, astronomy and cosmology. The author (a devout

37° 31' 33" N

77° 35' 41" W

COMETS-METEORITES-BLACK HOLES

☐ **Meteorites & Their Origins,** McCall	19.95
☐ **Nature and Origin of Meteorites,** Sears	17.95
☐ **Black Holes,** Sullivan	17.95

SUN

☐ **Sunspots,** Bray/Loughhead	7.00
☐ **Eclipse,** Brewer	6.95
☐ **Sundials,** Mayall/Mayall	11.95

PHOTOMETRY

☐ **Photoelectric Photometry of Variable Stars** Hall/Genet NEW!	15.00
☐ **UBVRIJKL Photometry of Bright Stars**	18.95
☐ **Photoelectric UBV Obs. of RR Lyrae Variable Stars** Johnson	4.50

DON'T SEE WHAT YOU NEED?

As you can see from the titles offered in this ad, we not only carry elementary works but many for the advanced amateur and professional. If that title you need is not listed here, we probably stock it—or failing that can track it down and get it to you in the fastest possible time. We stock nearly 1,000 individual titles in optics, astronomy and physics—including publications from NASA, The International Astronomical Union, and space related maps from the U.S. Geological Survey. We ship over 90 percent of our orders the day they are received. Our catalog is sent free with order; if requested alone—$1.00.

IAU PUBLICATIONS
MAPS
NASA PUBLICATIONS

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE.
Foreign Customers–please write for free Proforma Invoices!

Charge My: ☐ VISA ☐
MC INTERBANK NO. ☐☐☐☐
CARD EXPIRES MO. YR.
11/81
CHARGE CARD NUMBER ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
SUB TOTAL $ ______
HANDLING 1.00
VA: + 4% Tax ______
TOTAL $ ______
CARD HOLDER NAME (PLEASE PRINT!) ______
CARD HOLDER SIGNATURE ______
NAME ______
ADDRESS ______
CITY ______ STATE ______ ZIP ______

HANDBOOKS

Burnham's Celestial Handbook	
☐ Vol. 1, Andromeda thru Cetus	8.95
☐ Vol. 2, Chamaeleon thru Orion	8.95
☐ Vol. 3, Pavo thru Vulpecula	9.95
☐ **Telescope Hdbk. & Star Atlas** Howard	16.95
☐ **Astro. with Binoculars** Muirden	9.95
☐ **Amateur Astronomers Hdbk** Muirden	12.95
☐ **Astronomical Calendar 1982** Ottewell NEW!	8.00
☐ **Astronomical Companion** Ottewell	12.00
☐ **Using the Telescope** Robinson	12.95
☐ **Amateur Astronomers Handbook** Sidgwick **4th Edition** (Rev. Muirden)	24.95
Webb Society Deep-Sky Observer's Handbook	
☐ **Vol 1.** Double Stars	7.95
☐ **Vol 2.** Planetary & Gaseous Nebulae	9.95
☐ **Vol 3.** Open & Globular Clusters	13.95
☐ **Vol. 4** Galaxies NEW!	15.95
☐ **Vol. 5** Clusters of Galaxies	WRITE
☐ **Astronomy: A Handbook,** Roth	19.95

HISTORY

☐ **Planet Saturn, History of Obs**	8.00
☐ **Star Names, Lore & Meaning** Allen	6.00
☐ **The Telescope,** Bell NEW!	5.50
☐ **History of the Telescope** King	8.95
☐ **History of Rocketry and Space Travel** VonBraun/Ordway 3rd Ed	25.00

TELESCOPES AND OPTICAL FABRICATION

☐ **Amateur Telescope Making** Vol. 1	10.00
☐ **Amateur Telescope Making** Vol. 2	12.50
☐ **Amateur Telescope Making** Vol. 3	12.50
☐ **All About Telescopes** Brown	8.95
☐ **How to Build a Dobsonian**	3.95
☐ **Stand. Hdbk. of Tel. Mkg.** Howard	9.95
☐ **Tele. Making Mag. Vols 1-12 ea**	2.50
☐ **Making Your Own Telescope** Thompson	9.95
☐ **Binoculars & All Purpose Telescopes,** Paul	6.95
☐ **How to Build Your Own Observatory** NEW!	3.95

PHOTOGRAPHY

☐ **LFK Astro. Exposure Guide**	4.50
☐ **Skyshooting** Mayall/Mayall	3.50
☐ **Outer Space Photography** Paul	10.95

REFERENCE

☐ **Amer. Ephemeris (Astro. Almanac) 1982** NEW!	WRITE
☐ **Explan. Supp. to American Ephemeris**	26.00
☐ **1982 Almanac for Computers** USN NEW!	8.50
☐ **Cambridge Encyclopaedia of Astro.**	40.00
☐ **Astro. Data Book 2nd. Ed.** Robinson	16.95
☐ **Guinness Book of Astro Facts & Feats**	17.95
☐ **Facts on File, Dict. of Astronomy** Illingworth	6.95

Willmann-Bell, Inc. – Sidereal Clock
21·15.
Set
View
Fast
Slow
Display
Min-Sec

NEW SIDEREAL CLOCK
Accurate to 1 Second in 650 Years*

Now an **assembled,** very **accurate** sidereal digital clock for a little more than the cost of 2 good eyepieces. Ideal for classroom, planetarium or observatory. Large 0.7" LED display can be easily read at 20 feet in classroom—farther at night in the dark. *Long term stability derives from the highly accurate 60 Hz frequency of the U.S. Power Grid.

☐ **Sidereal Clock with manual**	$79.95
☐ **Matching Solar Clock with manual**	49.95
☐ **Matching Universal Clock with manual**	49.95

ATLASES AND CATALOGUES

☐ **AAVSO Variable Star Atlas**	39.95
☐ **Atlas Borealis**	29.95
☐ **Atlas Eclipticalis**	29.95
☐ **Atlas Australis**	29.95
☐ **Catalogue—The System of Lunar Craters 4 volumes plus 4 large maps**	35.00
☐ **Atlas of Mars** NASA	9.00
☐ **Atlas of Mercury** NASA	16.00
☐ **A Master List of Non-Stellar Objects**	30.00
☐ **Hubble Atlas of Galaxies**	20.00
☐ **SAO Star Catalogue, 4 vol**	55.00
☐ **Norton's Star Atlas & Ref**	18.95
☐ **Messier Album** Mallas/Kreimer	13.95
☐ **Rev. New Gen. Catalog of Non-Stellar Objects**	24.50
☐ **Sky Atlas 2000.0 Field Edition**	14.95
☐ **Desk Edition** NEW!	14.95
☐ **Set of Desk & Field Editions**	24.95
☐ **Atlas & Gaz. Near Side of the Moon** NASA	18.30

MATHEMATICAL & POSITIONAL ASTRONOMY

☐ **Princ. Perturbations in Solar System** Airy	5.95
☐ **Astro. Formulae for Calculators** Meeus	13.95
☐ **Practical Astronomy With Your Calculator,** 2nd Ed. Duffett-Smith	10.95
☐ **Math. Astr. with a Pocket Calculator** Jones	18.95
☐ **Fundamental Astrometry** Podobed	12.00
☐ **Textbook on Spherical Asto.** Smart	16.95
☐ **Princ. Astrometry** VanDeKamp	21.95
☐ **Computational Spherical Astr.** Taff	32.00

PLANETS-MOON-ASTEROIDS

☐ **Jupiter** Gehrels	38.50
☐ **Pioneer Odyssey** NASA	9.85
☐ **Asteroids** Gehrels	19.95
☐ **Apollo Over the Moon** NASA	14.00
☐ **Voyage to Jupiter** NASA	7.50
☐ **Viking Orbiter Views Mars**	9.50

Willmann–Bell, Inc.

P.O. Box 3125
Richmond, Virginia 23235
United States of America

Monday–Saturday
9 A.M. – 9 P.M. E.S.T.
☎ (804) 320-7016

Serving Astronomers Worldwide
Since 1973

ACTUAL SIZE

Astronomy loving jeweler, established 45 years, offers this exquisite 14K gold "Big-Dipper" pin set with eight fine full-cut diamonds totalling .32 carats.

$895.00

Please specify white or yellow gold. Your complete satisfaction is guaranteed. Please allow 4-5 weeks for delivery. VISA, Mastercard, phone & mail orders welcome. Ohio residents please add sales tax.

Danford-Lowell & Son
1246 Euclid Avenue
Cleveland, Ohio 44115
(216) 621-6434

There is hopeful symbolism in the fact that flags do not wave in a vacuum

ARTHUR C. CLARKE

T-SHIRTS Don't just sit there out of focus—ask for our FREE CATALOG of technical T-Shirts with 125 designs from A(stronomy) to Z(oology). The seeing is good but the wearing is better.

ABOVE: White on navy, red or blue HANES 50-50 $7.75 each (Women's French Cut = 8.75, kids 6.75)
S-Med-Lg-XL 2 @ 7.35, 3 @ 7.10, 4 @ 6.65

SOFTWEAR UNLIMITED
Star Rt. Box 38-A, Winthrop, WA 98862

Celestron

W/CASE

C90 (1000mm) Tele	239.90
C90 Spott. Scope	289.00
C90 Astro	429.00
500mm F/5.6	249.90
750mm F/6	479.90
1250mm F/10 Tele	479.90
C5 (25X Tele)	695.00
C8 (40X Tele)	795.00

To order on Master Card or VISA Card, call toll-free 800-221-5662. Please write for price sheet on all photo equipment at low discount prices. **B&H Foto Corp., 17 Warren St., New York, N.Y. 10007 (212) 233-9190.**
Open Sunday 10 a.m. — 4 p.m. Daily 9 a.m. — 7 p.m. Friday 9 a.m. — 2 p.m. Closed Saturday.

ASTRONOMY presents

VOYAGER AT SATURN

Voyager 1 is now travelling into deep space.
Voyager 2 passed Saturn on August 24, 1981.

In this issue and in December, ASTRONOMY Magazine continues its comprehensive reporting on the Voyager Flybys with full coverage of Voyager 2 at Saturn. Supplement these important issues with the complete set of ASTRONOMY's "Voyager 1 at Saturn" issues:

October 1980: VOYAGER ENCOUNTERS SATURN, outlines the events for the Voyager 1 flyby, concentrating on the photography.

November 1980: WHAT WE KNOW ABOUT SATURN, written by a planetary scientist, summarizes our pre-Voyager knowledge of Saturn's history, its moons and rings.

December 1980: VOYAGER APPROACHES SATURN, reveals some preliminary results and photographs as the spacecraft neared Saturn.

January 1981: VOYAGER ONE AT SATURN, presents much data and many photographs from the flyby, with initial reactions from scientists.

February 1981: VOYAGER: SCIENCE AT SATURN, offers a wealth of detail, analysis and information on Saturn, its rings and moons.

March 1981: MORE SCIENCE FROM SATURN, completes the coverage of Voyager 1 with results on magnetic fields, radio science and Titan.

SPECIAL OFFER ON THIS 6 ISSUE SET

VOYAGER 1 AT SATURN

$12.00 value ALL 6 FOR $9.95

To order use the AstroMedia form bound into this magazine

Herakleitean) says, "It is a supreme mystery that the ever-changing should be ever so good and ever so enjoyable."

The Structure and Evolution of Normal Galaxies
S. M. Fall and D. Lynden-Bell, eds.
272 pages, hardcover, $29.95
Cambridge University Press (1981)

Though normal galaxies may be a "minority" and have "generally unimpressive looks" (to quote contributor Martin Schwarzschild), studies of them help us understand how all galaxies end up with the shapes and structures they have. The book's 16 observational and theoretical papers were given as technical papers at a NATO advanced study institute in late 1980.

Mysterium Cosmographicum
Johannes Kepler
267 pages, hardcover, $20.00
Abaris Books (1981)
(order from publishers: 24 W. 40th St. New York, NY 10018)

Kepler's *Mysterium Cosmographicum* (The Secret of the Universe) was published in 1596 (with a second edition in 1621). In it, Kepler announced the first of his three laws of planetary motion — that planets do not travel around the Sun in circular orbits, but in ellipses.

This book provides a facsimile (by photolithography) of the 1621 edition on the left-hand pages. Facing each of these pages on the right is a new English translation. Translator A. M. Duncan has provided a table of variants where the 1621 text differs from that of 1596, as well as a brief essay on Kepler's astronomical terminology.

Atmospheres
James P. Barbato and Elizabeth A. Ayer
266 pages, hardcover, $35; paperback, $12.95
Pergamon Press (1981)

Subtitled "a view of the gaseous envelopes surrounding members of our solar system," this book is intended as a primer on planetary atmospheres for undergraduate students who have already had some exposure to astronomy or meteorology. The amount of mathematical reasoning called for in *Atmospheres* is small, and anyone with more than a passing interest in planetary science should enjoy at least skimming it.

New Accessories!

The Dew Zapper™

Keeps dew from ruining your observing. Powered from 117v AC or 12v DC. Works alone, or with dew cap for maximum efficiency. No warm-air currents like some heated dew caps. For C-8. #3500—**$57**

Dew Cap for C-8

Slows heat-loss from corrector plate, reducing dewing. Matching orange color. Dew Zapper also recommended for complete dew prevention. #5180—**$34.95**

Giant Finder for C-8

Find those faint celestial objects! Our handy new 8x50 finder has both right-angle prism and straight-through adapters. Matching orange color, with metal mounting bracket. #5129—**$79**

Orion's Observer's Chair

No more stiff neck or sore back! Heavy construction chrome-plated steel with adjustable-height padded seat. Collapsable, only 6 lbs. light! #5935—**$47**

New Polar Alignment System for C-8

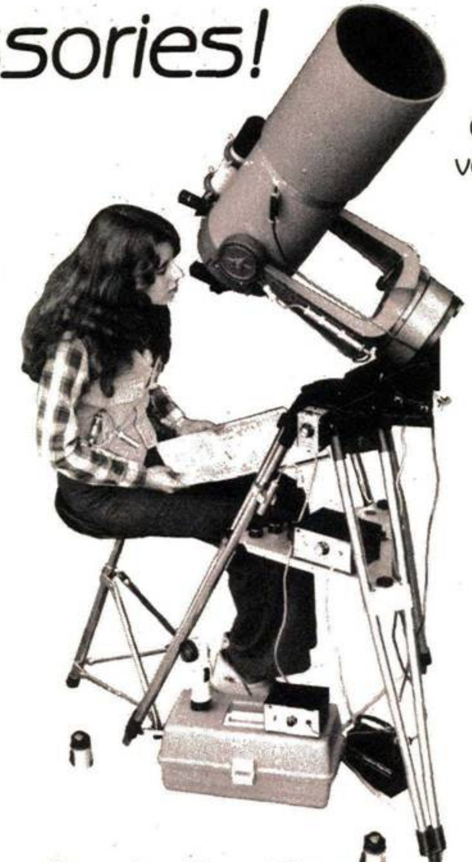
All you need for simple, fast polar alignment. Precise fingertip adjustment of azimuth (side-to-side) and altitude (up-and-down). Works with your setting-circles. With clear, simple instructions. Complete system, #5423—**$46.** Altitude only, #5421—**$19.95.** Azimuth only, #5422—**$29.95.**

Tripod Height Adjuster

Lowers your C-5/C-8 tripod to a comfortable height for viewing from a regular chair. Increases stability. Adjustable height. With special leg-tensioner knobs. #5441—**$27**

Equipment Case

Holds drive control, Porta-Pac, flashlights, cables, etc. Metal pin hinge and latch, recessed handle. 16½x8¾x7½. #5919—**$17**



Popular Favorites

Tripod Tote Bag, for C-8, C-5, with strap, #5006—**$24**
Setting-Circle Illuminator for C-8, #5750—**$29.95**
Aluminum Tripod Tray for C-8, #5721—**$43**
No-Tool Knob Set for C-5, C-8, 12 knobs, #5612—**$11.95**
The Astronomer's Flashlight™, with filters, #5701—**$7.95**
Porta-Pac Rechargeable Energy Cell, with charger #2352—**$59.95**
Mini-Marker Light, uses single 'D' cell, #5705—**$4.79**
Accessory Tray Light, with tripod clip, #5745—**$12.95**
Deluxe Pocket Flex-Light, with focusing head, #5704—**$14.95**

Quality Orion Eyepieces

Fully-coated 1.25" barrel Orthoscopic and Kellner eyepieces, selected for best value and performance. Threaded barrels with engraved focal lengths. Satisfaction guaranteed!

			Magnification		
Orion Stk. #	Focal Length	Type	C-8 (2000mm)	8" f/6 (1200mm)	Price
8471	5mm	Ortho	400X	245X	$26
8472	7mm	Ortho	285	175	$26
8474	9mm	Ortho	222	135	$26
8475	12.5mm	Ortho	160	100	$26
8466	18mm	Kellner	111	70	$18
8467	25mm	Kellner	80	50	$18
8469	40mm	Kellner	50	30	$18

Barlow Lens, 2X magnification doubles the power of any 1.25" eyepiece. For all reflectors, C-8. Large aperture. #7014—**$24**

Erecting Prisms, for straight-through viewing with Celestron and other compound telescopes, and refractors. 1.25" model, #7022—**$31.** .965" model, #7021—**$26.**

We're No. 1!

Orion Telescope Center is the largest volume Celestron dealer in the U.S.A.!

We love astronomy, and we love bringing amateur astronomers the finest equipment available at reasonable prices. Our commitment to fast service and customer satisfaction is why we're number 1. Whether you're interested in a telescope, or just want to talk to someone about your questions, Orion is always here to help you. Trust the friendly, helpful people at Orion for honest advice and fast, courteous treatment.

Thank you to our many customers. You are why we are here!

Orion Builds The Best!

AccuTrack® Electronic Control Systems for Astrophotography

Best selection, quality, performance.
Models for every telescope.

New FasTrack™ Dual-Axis Controller for C-8

- ☐ *Four-times faster correction rate*
- ☐ *Dual-rate control switch*
- ☐ *Illuminated-reticle power jack*
- ☐ *AC or DC powered operation*
- ☐ *OmniGuide™ joystick controller*

After extensive testing, Orion is proud to introduce this great new control system. With greater correction range than any competitive unit, our new FasTrack system is just what astrophotographers and visual observers have been waiting for. Works with our declination motor drive system (priced separately). Complete information is yours for the asking. #2120—**$179.95**

Improved Declination Motor

Now with slip-clutch for easy manual adjustment. Our handy dec. motor lets you make corrections during photography or viewing without the need to touch the telescope. No vibration! Mounts in minutes without drilling. Includes clutch assembly. Powered by our AccuTrack unit (above) or accessory hand control. #3903—**$44.95.** Hand control, #3909—**$14.95.**

Slip Clutch Only for upgrading our older model dec drives. #3910—**$9.95**

ORION
TELESCOPE CENTER

CATALOG

Only $1.00 (Free with order). Hundreds of things for the beginning or advanced astronomer. Includes free report: "Facts About Telescopes."

GUARANTEE

If you're not happy with any mail-order purchase return it in new condition within 30 days for a prompt, full refund. You be the judge!

OUR STORE

We're about one hour south of San Francisco, in beautiful Santa Cruz County. 2215 41st Ave., Capitola, Calif. We would love to see you!

ORDERING INFO

$1.00 service charge on all orders under $15.00. Calif. residents add 6% tax. If you send check or money order, we pay shipping in continental USA only. Shipping added to credit card & COD orders.

P.O. Box 1158-A Santa Cruz, Ca. 95061 (408) 476-8715

ASTROMART

Astro-Mart is a free service department available to all our readers. No subscription is necessary to place an ad, but we can allow only 2 noncommercial ads per person per year. Please type or print your ad legibly — illegible ads will be discarded. You are limited to 40 words including your name and address. All ads are, of course, subject to editorial review for suitability. Be sure to allow 4-6 months for your ad to appear. AstroMedia assumes no responsibility for statements made in classified ads, nor for the quality of advertised items. We cannot acknowledge classified orders nor provide checking copies.

ADVERTISER LISTING

ADVERTISER **PAGE**
Abraxas ... 88
Ad-Libs Astronomics ... 42
American Science Center ... 90
Astro-Cards ... 87
Astronomy New England ... 102
Astro Scenes ... 42
Astronomy Shoppe ... 90
Bernardo ... 88
B&H Foto ... 84
Bulb Miser ... 93
Celestial Prod. ... 87
Celestron International .. 80-81, 103, 116
Coast Nav. ... 92
Colonial Optical ... 91
Cosmic Connections ... 100
Coulter Optical ... 65
Criterion Mfg. Co ... 69,115
Crown Optics ... 101
Danford-Lowell & Son ... 84
Dover Sci. ... 90
Edmund Scientific ... 35
Enterprise Optics ... 89
E&W Optical ... 92
Fiber Light ... 88
Ganymede ... 86
Gall Pub. ... 89
Hansen Planetarium ... 91
Halley Fund ... 31
Hirsch, Edwin ... 87
Hoosier ... 91
Information Unlimited ... 87
L-5 Society ... 91
Luft, Herbert A. ... 89
Lumicon ... 100
Meade Instruments ... 2-3,58-59
Optica b/c ... 92
Optron Systems ... 88
Orion Telescope Ctr ... 43, 85
Ottewell ... 39
Publishers Central ... 87
Questar Corp. ... 60, 92
Rand McNally ... 88
S & S Optika ... 64
Scamp Trailers ... 89
Sky Research ... 91
Sky Scientific ... 90
Softwear Unltd. ... 84
Space Enterprises ... 92
Space Graphics ... 86
Space Studies ... 79
Spherical Concepts ... 100
Star Instruments ... 92
Star Tracker ... 78
Super-T ... 90
Tele Vue Optics ... 78
Texas Nautical Repair ... 88
Tomlin Ent. ... 89
Tuthill, Roger ... 76-77
Universal Life Church ... 86
University Optics ... 89
West, J.B. ... 91
Wiley, John & Sons ... 42
Willman-Bell ... 83
Wilson Prod. ... 89
Woodstock ... 87

FOR SALE — ASTRONOMY back issues January 1975 through 1980, good to excellent condition. $50. Contact Stephen Smith, 5995 Grove Hill Rd., Frederick, MD 21701.

FOR SALE — NASA fact publications, books on astronomy and *Omni* back issues (May 79 to present). 50% off. Also, TRC-81 Realistic walkie-talkie ($20). Used once. Write for list. Contact Ted Holland, 60 Pond St. Wakefield, RI, 02879. Phone (401) 783-7133.

Beginning Astronomy Course

6 cassettes and star manual $49.50 History of Astronomy, learning the sky, space flight, the new universe, & more. Fascinating & Educational for both Adults & Children.

ULC
1335 Seabright Ave.,
Santa Cruz, CA 95062

FOR SALE — Celestron 5 with fork mount and accessories, $650. Save hundreds from list price. Contact Stan Wnukowski, 292 Middle Rd., Hazlet, NJ, 07730, Phone (201) 264-1928.

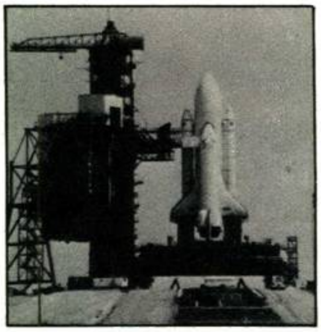
FOR SALE — Astroscan 2001: 4¼" f/4 richest field telescope, $250 includes 28mm (16x) and 8mm (56x), 4mm orthoscopic (111x) image erector, manual, "Using your Astroscan," standard accessories. Contact Don Pilcher, 1734 W. Harding Way, Stockton, CA 92503.

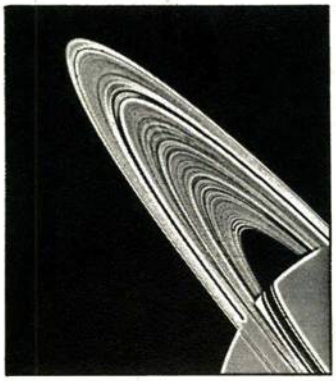
FOR SALE — Meteorite collection on a piece by piece basis. Write for list of specimens. Contact Jim Westcott, P.O. Box 327, Sedona, AZ 86336.

FOR SALE — Unitron 2.4" refractor, Unihex, 6 eyepieces, altazimuth mount, extras, $ 350. Contact Bill Hannum, 2322 Knob Hill, Apt. 16, Okomos, MI 48864, Phone 349-6494.

FOR SALE — Jaegers equatorial mount and pedestal, with setting circles and clock drive (friction clutch), $80. Excellent condition. Contact Wesley K. Martin, N. 5707 Alberta St., Spokane, WA 99208.

TELESCOPES
Refractors: 40mm to 150mm Diameter
Terrestrial — Astronomical
Special Optical Accessories
Refractor Component Parts
Hundreds of items, Free Catalog
GANYMEDE OPTICAL
P.O. Box 124, Narberth, PA 19072
(215) 664-4610





NASA PHOTOS

SPECTACULAR RESULTS FROM NASA!

JUST RELEASED! SPACE SHUTTLE/VOYAGER — SATURN

—SPACE SHUTTLE SLIDE SETS—
20 SLIDE SET — $12.95
40 SLIDE SET (incl. Narrative Cassette) — $16.95
POSTAGE AND HANDLING FOR EACH ABOVE SET — $2.50

—SPACE SHUTTLE PHOTOGRAPHS—
HIGH QUALITY PRINTS
SET OF TWO, 8x10 - $6.00 SET OF TWO, 16x20 - $16.00
POSTAGE AND HANDLING FOR EACH 8x10 SET — $3.00
16x20 SET — $5.00

—SPACE SHUTTLE POSTER SET—
THREE 24x36 COLOR POSTERS — $12.95
POSTAGE AND HANDLING FOR EACH POSTER SET — $3.00

JUST RELEASED!

—VOYAGER II—SATURN SLIDE SET—
20 SLIDES (With Photo Analysis Report) — $12.95
—VOYAGER I—SATURN SLIDE SET—
20 SLIDES (With Photo Analysis Report) — $12.95
—VOYAGER—SATURN MINI POSTER SET—
TWO 11x17 COLOR POSTERS — $5.00
—VOYAGER—SATURN POSTER SET—
FIVE 24x36 COLOR POSTERS — $14.95
POSTAGE AND HANDLING FOR EACH SLIDE OR POSTER SET — $3.00

NEW! SPACE CATALOG — .75¢

CALIFORNIA RESIDENTS ADD 6% TAX. FOREIGN ORDERS ADD AN ADDITIONAL $2.00. ALLOW 3 WEEKS FOR DELIVERY
POSTAGE AND HANDLING MUST ACCOMPANY ORDER

•SPACE GRAPHICS •
P.O. Box 764, DEPT. A CHATSWORTH, CALIF. 91311
(213) 716-7503

WANTED — Manual or electric slow-motion declination axis control, and rotating ring system for 8" telescope, both to fit a 1" shaft Cave mounting. Contact Ron Cole, 176 Forest Knolls Estates, Crookston, MN 56716.

NASA SPACE PHOTOS

Beautiful! Highest quality!
FREE COLOR CATALOG

Woodstock Products Inc.
P.O. Box 2519-A
Beverly Hills, CA 90213

SPECTACULAR!

1982
THE ORIGINAL from CELESTIAL PRODUCTS

THE 1982 LUNAR PHASE POSTER—CALENDAR

Hang this exquisite graphic where all can appreciate. The detailed printing shows the astronomically correct phase of the moon for each date. Even the terminator has the proper elliptical projection! Dark blue "sky" with silver cresents creates fascinating patterns. Each phase is keyed to month, date and day of the week.

Big 16" x 37" poster comes nicely rolled in a plastic Gift Tube — just add a bow! We guarantee that all your friends will want one.

PROMPTLY SHIPPED BY FIRST CLASS MAIL

1 — $5.75 ppd   2 or more — $5.00 ea. ppd.
Discount gift list order form on request.

Check, M.O., VISA, MASTERCHARGE
Send Name, Address, Acct. #, Exp. date to:

CELESTIAL PRODUCTS, INC.
Dept. A, 10 W. Washington Street
Middleburg, Virginia 22117-0810

ASTRONOMY & SPACE SLIDES

GALAXIES & NEBULAE	50 - $19.50
OBJECTS OF THE SOLAR SYSTEM	20 - $ 8.50
THE SUN/HISTORY OF A STAR	20 - $ 8.50
SPECIAL - ALL 90 slides above	90 - $32.95
APOLLO 11 Giant set in album	100 - $26.95
APOLLO 12, 14, 15, 16, 17	80ea. - $23.95ea.
EARTH FROM SPACE	25 - $ 9.75
MARINER 10 - Mercury & Venus	34 - $16.00
MOUNT ST. HELEN'S ERUPTION	18 - $ 8.50
PIONEER VENUS	30 - $15.00
*SPACE SHUTTLE first flight	20 - $ 8.50
U.S. NAVAL OBSERVATORY SLIDES	40 - $16.00
VIKING 1 - Landers on Mars	63 - $28.00
VIKING 2 - Landers on Mars	29 - $14.50
BEST VIKING - Mars	20 - $ 9.50
BEST VOYAGER 1 - JUPITER	20 - $ 9.50
BEST VOYAGER 2 - JUPITER	20 - $ 9.50
VOYAGER - JUPITER SPECIAL	100 - $29.95
BEST VOYAGER 1 - SATURN	20 - $ 9.50
VOYAGER 1 Saturn Encounter	40 - $16.95

Send 35¢ stamp for FREE slide catalog. Outside USA add 20% extra for airmail postage.

ASTRO CARDS
P.O. Box 35, Natrona Heights, PA 15065

BOOK LOVERS LOVE US.

Music lovers too!

HUGE SAVINGS!
UP TO 83% BY MAIL!
on outstanding... BOOKS & RECORDS
FREE!

We're Publishers Central Bureau and we've been offering savings of up to 83% on bestsellers, publishers remainders, overstocks, and new, complete editions of books, records and cassettes for nearly 50 years. We stock over 20,000 titles covering every subject from Art to Cooking, Fiction to Reference works, Beethoven to Buddy Holly. Many of our titles are unavailable elsewhere and all are unconditionally guaranteed. Send now for our latest catalog without cost or obligation.

Complimentary Catalog Request

Publishers Central Bureau
Dept. EB • One Champion Avenue
Avenel, NJ 07131

Please Use Block Letters

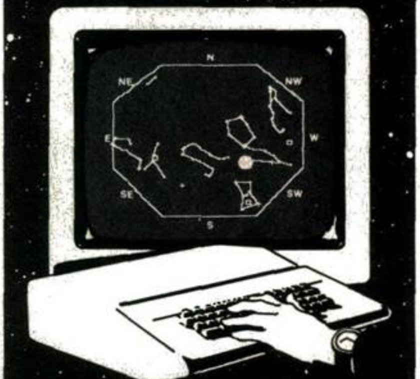
Name ______________________

Address ______________________ Apt. No.

City ______________________

State ______________________ Zip

THE UNIVERSE AT YOUR FINGERTIPS



TellStar™

for the Apple II

Choose a date, time, and place on Earth and let **TellStar** display the Stars, Planets, Sun, Moon and fascinating Stellar Objects in High Resolution Graphics.

With interactive commands, **TellStar** enables you to easily locate and identify stellar objects. Right Ascension, Declination, Azimuth, Elevation, Rise and Set Times are presented adjusted for precession. Planetary data is calculated using Kepler's equations. Constellations are drawn before your eyes. Print High Resolution Graphics displays on a Silentype. Scientific data can be printed on any printer.

A Calculation Utility is provided for equatorial, ecliptic, horizontal, and precession conversions.

TellStar Level I on disk **$39.95**
  Northern Hemisphere Star Tables
TellStar Level II on disk **$79.95**
  Comprehensive 47 page manual
  Northern Hemisphere Star Tables
  Southern Hemisphere Star Tables
  Messier Object Star Tables

Visit your local computer store for demonstration or write for more information.

Name ______________________

Address ______________________

City ______________________ Zip ____________

Information Unlimited Software, Inc.
281 Arlington Avenue
Berkeley, CA 94707
(415) 525-9452

TellStar is a trademark of Scharf Software Services.
Apple is a trademark of Apple Computers, Inc.

Edwin Hirsch

COMPETITIVE PRICES
PERSONAL SERVICE
FREE EXPERT ADVICE

Criterion: *New 4"* ***Dynamax*** *— RV6 - RV8* ***Dynascope***
Tele Vue: Plössl *Eyepieces — Superior Performance*
Coulter Optical: Odyssey 1 *— 13.1" Dobsonian*
Meade: *Schmidt-Cassegrain and Newtonian*
Daystar: *Hydrogen-alpha Solar Filters*
Celestron • Edmund • University

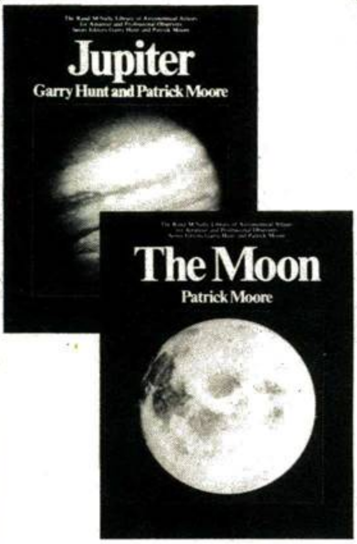
EDWIN HIRSCH, Well known to astronomers for his remarkable filtergrams of the Sun taken with the famous DAYSTAR H-alpha Solar Filter, shows our Sun and its thousands of faces of ever-changing detail. **EDWIN HIRSCH** also serves on the staff of Astronomy Island.

17 YEARS ASTRONOMY EXPERIENCE to Help You Select Optimum Telescope and Accessories for Your Personal Needs.

Edwin Hirsch
168 LAKEVIEW DR.
TOMKINS COVE, N.Y. 10986 • (914) 786-3738

ASTRO MART

The New Rand McNally Astronomy Atlases



Latest and Most Authoritative Books on the Subject

THESE extraordinary books, the most complete and up-to-date available, are backed by the authority of the Royal Astronomical Society. The text, by Patrick Moore and Garry Hunt, summarizes latest scientific findings and describes current ideas about the Moon, Jupiter, and that planet's four largest satellites, the "Galileans."

Hundreds of spectacular illustrations, many in color, include recent NASA space probe photos and exclusive maps of both sides of the Moon.

JUPITER
by Garry Hunt
and Patrick Moore

THE MOON
by Patrick Moore

A superlative gift for the amateur and professional observer.
8¼" x 11" $14.95 each

wherever books are sold
Rand McNally
P.O. Box 7600, Chicago, Ill. 60680

MEADE
QUANTUM
BUSHNELL
CELESTRON
ACCUTRACK
KALT CORP.
SWIFT INST.
VERNONSCOPE
SMITH-VICTOR
DAYSTAR FILTERS
EDMUND SCIENTIFIC
UNIVERSITY OPTICS

YOU CANNOT AFFORD TO BUY A CELESTRON
Without Calling Us For The Most Competitive Prices To Be Found Anywhere.

96 pages of catalogs and manuals-$3 refund with first order. $5 foreign.

FREE PRICE LIST ON REQUEST.

Demonstrations by appointment, or call to discuss your specific needs.

OPTRON SYSTEMS
Eugene L. Cisneros
704 Charcot Avenue
San Jose, California 95131, U.S.A.
Phone: 408-946-4797 daytime
408-923-6800 evening

Pre-Columbian Astronomers!

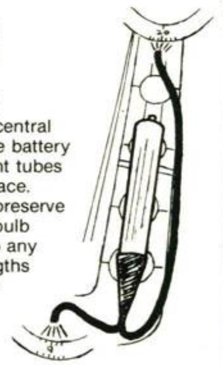
The Maya were superior astronomers: created an accurate calendar/predicted eclipses/mapped stars. Original rubbings of ancient Mayan ruins! Color catalog $2.00 (refundable with order).

BERNARDO
2400 Westheimer #108W (A)
Houston, TX 77098

FIBER OPTICS TO ILLUMINATE YOUR SETTING CIRCLES

$19.95 plus $1.50 Shipping and Handling

Optical fibers use one central light source to conserve battery life. Wire reinforced light tubes adjust and remain in place. Projects red beams to preserve night vision. No bulky bulb ends. Easily attaches to any mount. Light guide lengths adjustable. Instructions included.



SEND CHECK OR MONEY ORDER TO:
FIBER LIGHT • Box 8228
• Prairie Village, KS 66208 • 1-913-381-4000

TEXAS NAUTICAL
REPAIR CO.

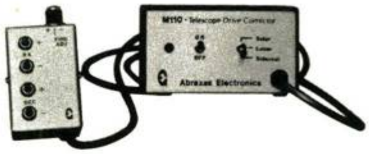
Sales and Service for telescopes, binoculars, microscopes, and other optical equipment.

In the last 30 years we've grown to be the largest dealer in the Southwest.

Call or stop by our showroom for products by Bausch and Lomb, Bushnell, Celestron, Clave', Edmund, Fujinon, Leitz, Meade, Nikon, Orion, Sky Publishing, Swift, University Optics, and Zeiss.

3209 Milam, Houston, Texas 77006
(713) 529-3551

M110 DUAL AXIS DRIVE CORRECTOR



- 20 watt output • 3 preset rates
- Powered by 117VAC or 12VDC
- Short circuit and polarity protected
- 2 year parts and labor warranty
- ±12 VDC declination output (AC available)
- Built with the highest quality components and fully tested

Available from: **$194.95**

Abraxas Electronics
P.O. Box 1188
Littleton, CO 80160
(303) 979-6102

Also available with new
Slik•Stik Joy Stick Control

D2

Hand Figured Telescope Mirrors

• Custom Made Telescopes • Accessories
Send $1.00 for Catalog
$2.00 outside North America

ENTERPRISE OPTICS
P.O. Box 413 • Placentia, CA 92670
(714) 524-7520

TRAVEL TRAILERS

SCAMP — All fiberglass, light weight travel trailer 950 lbs. Factory direct. Call toll free 1-800-4962 for free color brochure. SAVE BIG BUCKS!!!

NEW! THE NEW SOLAR SYSTEM Ed. by J.K. Beatty and B. O'Leary	$19.95
NEW! THE COMET IS COMING (HALLEY) by N. Calder	$12.95
NEW! COMPUTATIONAL SPHERICAL ASTRONOMY by L.G. Taff	$28.95
BURNHAM'S CELESTIAL HANDBOOK, VOL I, VOL II, VOL III–EACH	$ 8.95
NEW! DAYTIME STAR–THE STORY OF OUR SUN by S. Mitton	$14.95
PLUTO by C.W. Tombaugh & P. Moore	$14.95
AAVSO STAR ATLAS	$39.95
AMATEUR ASTRONOMERS HANDBOOK by J.B. Sidgwick, hard cover, 4th edition	$24.95
soft cover, 3rd edition	$ 6.75
OBSERVATIONAL ASTRONOMY FOR AMATEURS by J.B. Sidgwick, soft cover	$ 4.75
AMATEUR TELESCOPE MAKING, 3 Vols.	$35.00
NORTON'S STAR ATLAS	$18.95
NEW! SKY ATLAS 2000 by W. Tirion	$14.95
THE TELESCOPE by L. Bell, reprint	$ 6.50

Write for NEW enlarged free list of astronomical literature

Herbert A. Luft
P.O. BOX 91, OAKLAND GARDENS, NY 11364

CELESTRON	
C90 Spotting Scope	$ 280
C5 Telescope	685
C8 Telescope	765
C11 Telescope	2450
C14 Telescope	5100
Wedge 5/8	50
Tripod 5/8/90	130
MEADE	
645 6″ f/5 with drive	465
826 8″ f/6 with drive	575
2080 some available	
TOMLIN	
Light Weight Field Tripod. *(Ideal for Catadioptric Systems)*	65
Kellner Eyepieces f.1. 6, 12, 25, & 40 mm	18

OTHER ITEMS
Binoculars, Telescope Tubes & Mounts, Colored Slides & Murals, Mirror Cells, etc.

ASK ABOUT THIS MONTH'S SPECIAL OFFER!!

Free Shipping in continental United States

Personal checks allow 2-4 weeks to clear. California residents add 6% sales tax. All shipments made upon acceptance of your order. 52 page Meade General Catalog and 52 page Celestron Catalog . . . $5.00 ppd.

Tomlin Enterprises
Showroom 4565 Industrial St., Suite 7H
Mail orders 1036 Stanford Dr., Dept. A
Simi Valley, California 93065 (805) 522-6646

USSR

TOUR THE SOVIET OBSERVATORIES

Dr. Bart Bok returns to the Soviet Union to tour the major astronomical installations from **July 19 to August 15, 1982.**

A shorter tour starting early August will also be offered.

You may return home or continue with Dr. Bok to the IAU Convention in Greece.

JAVA, JUNE 11, 1983

We are planning a tour via Australia to see five-minute total solar eclipse.

Write for details.

Gall Astronomical Publications
1293A Gerrard Street East
Toronto, Ontario, CANADA
M4L 1Y8 (416) 469-4171

INTRODUCING THE CELESTRON CAP

Celestron
Telescopes · Telephoto Lenses

White front, colored bill and mesh back printing is orange and brown

Highest Quality—Adjustable

ORDER IN TIME FOR HOLIDAY GIFTS

PRICE—$5.95 each plus $2.00 shipping & handling
(3 or more caps postage paid)

PLEASE SPECIFY COLOR:
Orange, Brown, Gold, Blue or Green

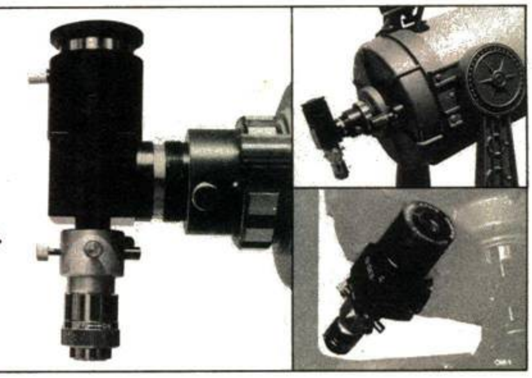
SEND CHECK OR MONEY ORDER TO:

WILSON PRODUCTS
P.O. Box 8228
Prairie Village, KS 66208
(913) 381-4000

Celestron Caps and Patches

A revolutionary advancement in the field of astrophotography!
Master Guide, the illuminated guider with a movable reticle!

USES ANY FOCAL LENGTH EYEPIECE. SOLD SEPARATELY.
FOCUSABLE EYEPIECE.
REMOVABLE 2X BARLOW.
RETICLE PROJECTION TUBE.
360° ROTATION LOCK.
RETICLE ADJUSTMENT SCREWS.
PILOT LIGHT.
ON-OFF SWITCH.
BRIGHTNESS CONTROL.



Using Master Guide, for the first time you can move the reticle anyplace within the field of the guiding eyepiece without touching the telescope's controls. Look in the eyepiece, locate a guide star, then use the micrometer controls to "lock" the reticle on the star. Saves time, saves film. Get better astrophotographs!

The Master Guide also serves as an important teaching tool. The instructor can pinpoint a number of objects within the field of view for student identification without moving the telescope.

Removable 2X Barlow for extra magnification. Works with the Celestron and Meade off-axis guider.

Send for our free brochure explaining the problems associated with guided astrophotography and how the Master Guide can solve them. When ordering, please indicate 1¼″ O.D. or .96″ O.D.

$129.95 ppd.

TOLL FREE 800-521-2828 TO ORDER • **UNIVERSITY OPTICS INC.** 2122 E. Delhi, Box 1205 ANN ARBOR, MICHIGAN 48106-1205 • **FREE CATALOGUE**

The Finest Telescopes and accessories...from the leader of low prices and fast reliable service.

Celestron

C-90 Spotting scope	$290
C-5 Base price	$619
C-8 Base price	$750
C-11 Base price	$2350
C-14 Base price	$4850

Meade

Please call or write for quotes.

Edmund

Astroscan 2001	$165

All above telescopes (ex. C-11, C-14) shipped free in continental U.S.

Similar savings on all other telescopes and accessories. We personally pick up Celestron and Meade telescopes from the factory. Our direct contact with the factory insures complete control of your order. Most orders available for shipment within 24 hours. Fast delivery on C-14s too. All telescopes are fully warranted for an entire year, plus our own 30-day unconditional guarantee which entitles you to a full refund with no questions asked.

SOLAR FILTERS
Full Aperture

Made from high-quality optical glass, aluminized and overcoated. Great for both visual and photographic use. Available unmounted or mounted in all the popular sizes.

	Mounted	Unmounted
4"	59.00 ppd	39.00ppd
5-6"	79.00ppd	49.00ppd
8"	92.00ppd	62.00ppd
10"	109.00ppd	75.00ppd
12½"	139.00ppd	99.00ppd
14"	199.00ppd	140.00ppd

Please specify Telescope Brand.

Mylar Solar Filters

All Mylar Solar Filters are mounted and ready to use.

4"	5-6"	8"	10"	12½"
32.95	34.95	39.95	49.95	69.95

Please specify telescope brand

TELE VUE PLOSSL EYEPIECES

7.4mm, 10.4mm, 17mm, 26mm ____ $55.00 ea ppd.

Free Meade model #51 accessory case with the purchase of one. Free #54 accessory case with the puchase of 4.

Send for our complete listing of accessories. We also carry a large selection of books and star atlases.

ASTRO WALL MURALS

Moon & Stars 8'8" x 20'9" $69.95
Earthrise 8'8" x 13'8" $39.95
Saturn 8'*" x 13'8" $39.95
Send for free brochures.

Free discount price list sent on request, or you may order any one or all of the following: Celestron 32-page color catalog $1.50. Meade 50-page catalog $2.25. Edmund Scientific catalog $1.00. (Add $1.50 each for airmail outside North America.)

Free shipping on most items in the continental U.S. Allow 2 weeks for personal checks to clear. California residents add 6% sales tax. Shipping extra on COD and credit card orders.

THE ASTRONOMY SHOPPE

Box 2001C
Newbury Park, CA 91320
Call 805-499-1501
10 a.m. to 6 p.m. Mon thru Fri.

ASTRONOMY T-SHIRTS

TOP QUALITY
PHOTO SILK SCREEN
ONLY $6.95
3 FOR $19.95

Adult or Children's
Sizes S, M, L, XL

NGC 5272

STYLES INCLUDE:

- **Andromeda Galaxy** (Navy) - #A-1
- **Solar Eclipse** (Black) - #E-2
- **Astronomers Love Heavenly Bodies** (Lt Blue) #B-3
- **Doradus Nebula** (Navy) #D-4
- **Pleiades** (Black) - #P-5

OTHER STYLES

- **Crab Nebula** (Black) #C-6
- **Morehouse Comet** (Navy) #M-8
- **NGC 5272** (Navy) #N-7
- **Great Conjunction** (Lt. Blue) - #G-9
- **Space Shuttle** (Tan) - #S-10

Send to: Super—T
2345 NE 52nd St.
Gainesville, FL 32601

Include $1.50 Postage
Amount enclosed ____
(outside U.S. & Canada – Add $3 postage. Please send in U.S. funds)

QUANTITY	STYLE	SIZE	AMOUNT

NAME ____
ADDRESS ____
CITY ____
STATE ____ ZIP ____

ASTRO MART

FREE DOVER SCIENCE CATALOG

Free 64-page catalog of over 300 fine science paperbacks including books on astronomy, cosmology, physics and mathematics. Classics of science and contemporary works, basic to advanced level. Catalog absolutely **FREE!** Write Dover Pubns., Dept. A46, 180 Varick Street, New York, N.Y. 10014. "The happy pioneer in the field of scientific paperbacks . . . attractive reprints at reasonable prices."—*The New York Times*

INSTANT ASTROPHOTOGRAPHY!

For beginning astrophotographers and educators — cameras accept Polaroid® film packs for instant celestial photography

SKY SCIENTIFIC
28561 Highway 18
PO Box 184
Sky Forest, CA 92385
Tel: (714) 337-3440

For advanced amateurs and professionals — our cameras also accept conventional sheet films. Prices start at only $75. Off-axis guider models from $105. Free brochure and photo

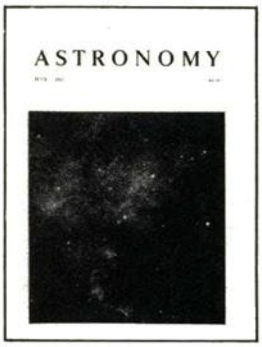
Authorized dealer for CELESTRON and MEADE

METEORITES FOR SALE

1 oz. to 2 oz. sizes are $70.00 Per Lb.
2 oz. to 4 oz. sizes are $60.00 Per Lb.
4 oz. to 1 lb. sizes are $50.00 Per Lb.
1 lb. to 3 lb. sizes are $45.00 Per Lb.
3 lb. to 7 lb. sizes are $40.00 Per Lb.
All Sizes Over 7 Lb. are $30.00 Per Lb.

All are Fe-Ni-Octahedrites from Pleistocene Era. - F.O.B. Rosebud for more information, send SASE to:

Mike Schigut, Box D
Rosebud, Texas, 76570 (817) 583-2019



THE HISTORY OF AMERICAN ASTRONOMY

From prehistory to planetary probes, our Bicentennial issue brings you the entire story of our nation's search in the skies. 112 pages, a unique collector edition.

orig. $3.50
Now $2.00

To order, use the AstroMedia form bound into this magazine.

SATURN!
NEW NASA RELEASE
VOYAGER 2. ENCOUNTER

40 Slides plus Cassette tape	$15.95
20 Slides	$ 9.95
Other sets of 40 slides plus tape	*$15.95 each*
Voyager 1 Saturn	
Voyager Jupiter	
Viking Mission to Mars	
Our Universe	
Space Shuttle Columbia — 20 Slides	**$ 9.95**

WRITE for listing of other slides and Posters.
WRITE for details on **ASTRODRIVE** — A quality Telescope Drive Rate corrector in an Easy-to-Assemble KIT that **SAVES** you Money.
Slides shipped ppd. in US. Foreign orders add 10% for postage and handling. California Residents add 6% tax.

J.B.WEST and Associates
Dept. A
P.O. Box 1493
Santa Barbara, CA 93116-1493
(805) 685-3296

L5 SOCIETY • 1060 E. Elm St. • Tucson, AZ 85719
Looking to space— for the answers to today's problems.
PROMOTING SPACE DEVELOPMENT

Space Is Waiting–

ARE YOU READY?

Let the monthly **L-5 News** help show you the way.

Help shape our national space policy to restore the U.S. lead in space technology.

Please enter my membership!
Name ____________
Address ____________
City ________ State ________ Zip ________
☐ $20 Regular ☐ $15 Student
☐ Please send more information

HOOSIER
TELESCOPE CENTER
4779 W. County Road 144
Bargersville, Ind. 46106

FULL-LINE CELESTRON, MEADE, STAR INSTRUMENTS, UNIVERSITY OPTICS, W.R. PARKS, QUANTUM, QUESTAR, DAYSTAR H-alpha, LUMICON, UNITRON

NEW MEADE 4" AND 8"
SCHMIDT-CASSEGRAIN
NOW AVAILABLE
Beat the price increase on Meade telescopes — order before June 1st.

4 p.m. - 10 p.m. Monday thru Friday
8 a.m. - 6 p.m. Saturday

CATALOGS: MEADE $3; CELESTRON $2; QUESTAR $2 PHONE (317) 422-9301

Mayflower
REFRACTORS & REFLECTORS
MAYFLOWER

MAYFLOWER telescopes are engineered to utmost precision. Lenses and prisms are made of purest optical glass, ground to exacting tolerances. The achromatic objective is fully color corrected for distortion-free viewing. Optics are coated to increase light transmission, resulting in brighter, sharper image. Mechanical system is sturdy and well engineered *giving smooth and flawless performance.* Choose from a large selection of MAYFLOWER Refractors and Reflectors.

At leading stores everywhere.
Write for free brochure.

All Price Ranges

Importers: **COLONIAL OPTICAL COMPANY, INC. Phone: (213) 776-0777**
8415 SOUTH LA CIENEGA BLVD. • INGLEWOOD, CALIF. 90301

Space Shuttle!

FULL-COLOR POSTERS

The historic maiden voyage of NASA's Space Shuttle *Columbia* is commemorated with two full-color posters and a set of five color slides. One 22½" x 29" poster shows the fiery launch; the other shows the landing of *Columbia* after its flawless flight. Posters are suitable for framing and are mailed rolled.

☐ **$5.00 ppd. for both posters**

☐ **$1.00 ppd. for catalogs add $2.00 postage for foreign orders**

Hansen Planetarium
15 South State St., Dept. A-11
Salt Lake City, Utah 84111

8" Deep Sky Telescope

Dual-Purpose!

Super at High Power too!

$374
Shipping USA $22.50

COMPLETE
Ready to Use
Includes
DOBSONIAN-TYPE MOUNT

Compact Telescope 21" Long
Lifts Out!

HUGE FIELD OF VIEW
• Brilliant Images •

Big Low Profile 2.0" Focuser

Sealed Against Dirt, Moisture

Optical Window

Catalogs *FREE*

SKY RESEARCH
P.O. Box 2778
Santa Cruz, CA 95063
(408) 423-3275

ASTRO MART

STAR INSTRUMENTS

Refigure Coulter 17.5″ mirrors to ¼ wave front for $450.00 TCC.

18″ f/4.4 Dobsonian Mirror $1,100.00 TCC

24″ f/4 Dobsonian Mirror $2,200.00 TCC

Made from 1⅝″ Pyrex, ¼ wave front, tested by autocollimation and aluminized/silicon overcoated. Delivery 2 to 3 months.

Star Instruments also makes custom optics as well as Schmidt-Cassegrain, Schmidt cameras, Ritchey-Chretien, Classical and Dall-Kirkham Cassegrains and Newtonians using our lightweight dish and cellular mirror blanks up to 48″.

Call 602/526-1991 or send $1.00 ($2.00 U.S. currency Canada and Foreign) for catalogue:

STAR INSTRUMENTS
3641 E. Fox Lair Dr.
Flagstaff, AZ 86001

LEARN ASTRONOMY AT HOME

For the first time the world famous Coast Navigation School home study course in astronomy is available as a self-study program* This completely self-contained course will introduce you to the wonderful world of the heavens in only a few short weeks. Proven successful by thousands of students over the past fifteen years. Special prices on Celestron telescopes. Call Toll Free for details 800-638-0420.

*Optional individualized instruction and certificate program available.

Coast Navigation
Dept. 51 1934 Lincoln Dr.
Annapolis, MD 21401
(301) 268-3122

Please send me your complete visual Astronomy course for only $27.

Name ______________________

Address ______________________

City __________ State _____ Zip _____

☐ Please send me your complete school catalog.

CELESTRON TELESCOPES
ON DISPLAY AND IN STOCK
E & W OPTICAL, INC.
2420 EAST HENNEPIN AVE.
DEPT. AM
MINNEAPOLIS, MINN. 55413
612-331-1187
SEND FOR PRICE LIST "A"
Astronomy supplies and accessories

THE QUESTAR ALMANAC FOR 1982

This 32-page almanac, designed to fit breast pocket or handbag, will keep you informed ahead of time about the whole year's goings-on in the sky. It's a convenient ready reference to the celestial objects of interest every night of the year, with photographs, helpful hints and items of general interest to the astronomer. You'll want to carry one with you all the time so that each day you can plan for the evening's observing. Makes a nifty Christmas stocking stuffer, too.

Price $3 in North America; $5 in other countries. Delivery in early December.

QUESTAR
Box C, Dept. 80A, New Hope, PA 18938
(215) 862-5277

YOU ARE HERE

GALACTIC T-SHIRT

This white graphic on a Hanes 100% cotton navy blue t-shirt puts us all in galactic perspective. (This t-shirt also available as pictured at left with the words "What Limits To Growth?" underneath the galaxy.)

New T-shirt (words only):

"Zero Gravity Sex...It's Out Of This World"

SPACE SHUTTLE T-SHIRTS!

"4-color on light blue" T-shirt. Also available with the words "Conserve Earth—Colonize Space" or "America Needs Space To Grow."

Buttons $1.00 Bumperstickers $1.00

SPACE
THE HIGH FRONTIER

T-shirts $7.00 + $1.50 postage and handling each. Sizes: S,M,L,XL.
Absolute one month money back guarantee on all merchandise. Send check, money order, or charge card number to:

Space Enterprises, Dept. A
317 W. Davis
Yellow Springs, Ohio 45387

Please allow 4—6 weeks for delivery

T-SHIRTS	S	M	L	XL
You Are Here				
What Limits				
Space/High Frntr				
Conserve Earth				
Amer. Needs				
Zero Gravity Sex				

TOTAL = ______ × $8.50 = ______

	Button	**Bumper**
Space/High Frntr		
Conserve Earth		
Amer. Needs		

TOTAL = ______ × $1.00 = ______

Ohio residents add 4% sales tax ______

TOTAL = ______

Name (Please Print) ______________________

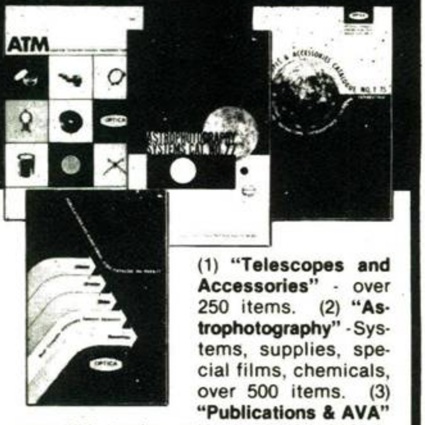
Address ______________________

City ________ State ________ Zip ________

☐Visa ☐Mastercard No. ________ Exp. Date ________

Signature ______________________

4 OPTICA b/c CATALOGUES

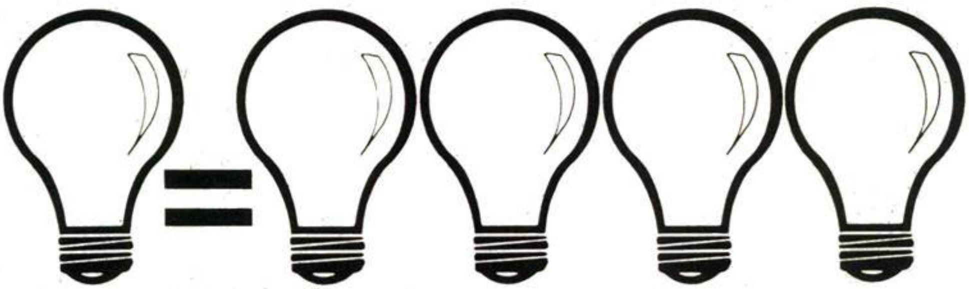


(1) **"Telescopes and Accessories"** - over 250 items. (2) **"Astrophotography"** - Systems, supplies, special films, chemicals, over 500 items. (3) **"Publications & AVA"** - over 300 books, atlases, maps, slides, posters, recordings, globes, etc. (4) **"ATM"** - goods for the telescope maker, - over 400 items. Each catalog - 50¢; all four - $1.50 for handling and postage. Send cash, check or U.S. stamps. Also receive **FREE** current Astronomical Events Calendar, a wealth of useful information. **FOREIGN** — Each catalogue $1.00; all four $3.00. Must be paid by an International Postal Money Order or a check drawn in U.S. Dollars on any bank in the U.S.A. For Airmail, add $2.00.

OPTICA

OPTICA b/c Company
ASTRONOMY DIVISION
4100 MacArthur Blvd., Oakland, Calif. 94619

INCREDIBLE FREE OFFER!

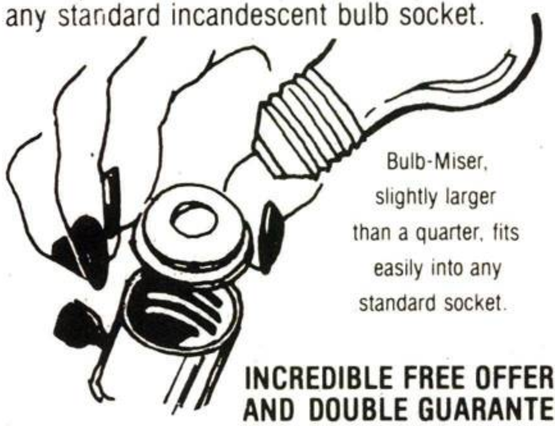


BULB-MISER® makes your light bulbs last 4 times longer, saves electricity, money, labor and never needs to be replaced!

The **Bulb-Miser** was developed during **NASA's** Apollo program to protect the Saturn launch vehicle from electrical current surge. It works in the same way, to protect bulbs, acting as a "thermal shock absorber," allowing the filament to heat up slowly to prevent burnout. The result: an average increase in bulb life of **300 percent**. In addition, **Bulb-Miser** also offers reduction of electrical energy. When **NASA** built its amazing energy-saving **"Tech House"** at its Langley Research Center, **NASA's** engineers specified that **Bulb-Miser** be used throughout. In a controlled experiment, a family of four lived in the house and according to a **NASA** press release "the family only replaced one light bulb all year."

What makes a light bulb burn out?
Everybody knows that most light bulbs burn out when you turn them on—that's the last shock that the filament takes before it breaks. That's because when the bulb is off, the filament is at room temperature. When you turn it "on", the filament gets a sudden surge of heat and electricity, shock after shock that weakens the filament until, it breaks under one of the "shocks".

Bulb-Miser protects your bulbs, saves money!
Bulb-Miser resists the initial power surge letting your bulb heat up without "shock"—thereby increasing bulb life 300%. And you don't sacrifice visible light with **Bulb-Miser**. . . it takes just a second for the filament to heat up and your bulb lasts 4 times longer. **Bulb-Miser** requires no "special" installation—it easily inserts into any standard incandescent bulb socket.



Bulb-Miser, slightly larger than a quarter, fits easily into any standard socket.

INCREDIBLE FREE OFFER AND DOUBLE GUARANTEE
Naturally, a product as good as **Bulb-Miser** comes with a money back guarantee. But we're so sure that you'll be delighted by SAVING MONEY, SAVING BULBS, SAVING TIME and SAVING ENERGY that we go beyond that. For a limited time, we're making the following NO RISK FREE OFFER. Buy three **Bulb-Misers** for $8.95 and we'll send you 1 **free**. Plus **Bulb-Miser** is GUARANTEED TO LAST FOR THE LIFE OF THE SOCKET. . . YES—GUARANTEED TO NEVER WEAR OUT OR WE'LL REPLACE IT **FREE!** — This offer is only available through mail order so order now while supplies last!

BULB-MISER® Corporation of America, Box 995, Northvale, NJ 07647 AM-IO

☐ **Yes,** I want to multiply bulb life 300%. I understand for every 3 **Bulb-Misers** I order, I will receive 1 free. You guarantee my satisfaction 100%. If I am not satisfied I will receive a full refund.

MONEY BACK GUARANTEE

Name ______

Address ______

City ______ State ______ Zip ______

Please send me: ______ package(s) of 3 **BULB-MISERS** at $8.95 PLUS 1 FREE **BULB-MISER** AT NO EXTRA COST. Please send check, money order or charge only.

Charge to: ☐ VISA ☐ MasterCard Exp. Date ______

Acct. # ______

Signature ______

Add $1.75 post. & hand. NJ Res. Add 5% Sales Tax. Amt. Enclosed ______

The First Galaxies

by Barry Parker

Today, with huge reflecting telescopes as surrogate eyes, astronomers peer at objects so far away that the distance to them takes on a new function — as a measurement of time. We look back in time when we put our eye to the eyepiece, and for the first time in history we are close to seeing the beginning of creation, as the increased power of our telescopes brings us nearer to the observational limit of the universe. In the classic Einsteinian sense, then, we peer at objects so old they approach the age of the universe.

In the depths of space we see millions of galaxies. Some are similar to our own Milky Way, but many are quite different. If we continue to probe deeper and deeper we find that ordinary galaxies gradually thin out. Beyond a distance of a billion or so light-years there are mostly radio galaxies, and beyond them — near the outer reaches of our observable universe — we see only quasars. When we look at these objects, we see ghostly images of how they appeared long ago. For instance, when we look at the nearby galaxy M-31 in Andromeda, we see it as it was two million years ago, because its light took that long to reach us. The quasars we see near the edge of our observable universe appear as they were many billions of years ago. Since we are seeing back into time, we could be witnessing an evolutionary sequence. In the outer regions of the universe — most distant in time — we see only quasars. Slightly closer we see mostly radio galaxies, and closer yet ordinary galaxies. Is it possible that quasars gradually evolve into radio galaxies which in turn evolve into ordinary galaxies?

While most astronomers do not believe we are actually seeing an evolutionary sequence, evidence is mounting that there is a connection between galaxies and quasars. A clue to the relationship comes from a type of galaxy discovered about thirty years ago by Carl Seyfert. Seyfert galaxies have extremely bright nuclei, and short photographic exposures of them record surprisingly stellar-like cores. However, with a longer exposure, their galactic arms can be seen clearly. Quasars, judging by the red shift of their spectra, are much farther away than Seyferts. In fact, they look very much like the nuclei of Seyferts, and it's possible quasars are the bright nuclei of very distant galaxies.

But several arguments contradict this possibility. First of all, many quasars are variable and some change brightness significantly in only a few days, indicating they must be small. One possible explanation for this phenomenon helps us clearly see what is taking place. The mechanism causing the intensity to change has to be synchronized across the diameter of the quasar by some kind of signal. This signal is limited by the speed of light. An object that changes its brightness in one year can't be any longer than one light-year across. If this is true, then quasars are extremely small compared to galaxies. Another objection centers around the differences between the spectra of galaxies and quasars. Both emission and absorption lines are seen in quasar spectra; galactic spectra exhibit only absorption lines. Also, a quasar's spectrum frequently shows several different red shifts and galactic spectra do not.

This difference in spectral content seems to indicate there is no relationship between galaxies and quasars. But strangely enough, several astronomers have recently shown that in a number of cases there is a connection — quasars appear to reside at the cores of galaxies. James Gunn of Hale Observatory and Joseph Wampler of Lick Observatory have independently shown that one of the first quasars discovered, 3C 48, has a distinct nebulosity associated with it. They believe 3C 48 is a galaxy with a nucleus so bright it overpowers the feeble light from the arms that surround it.

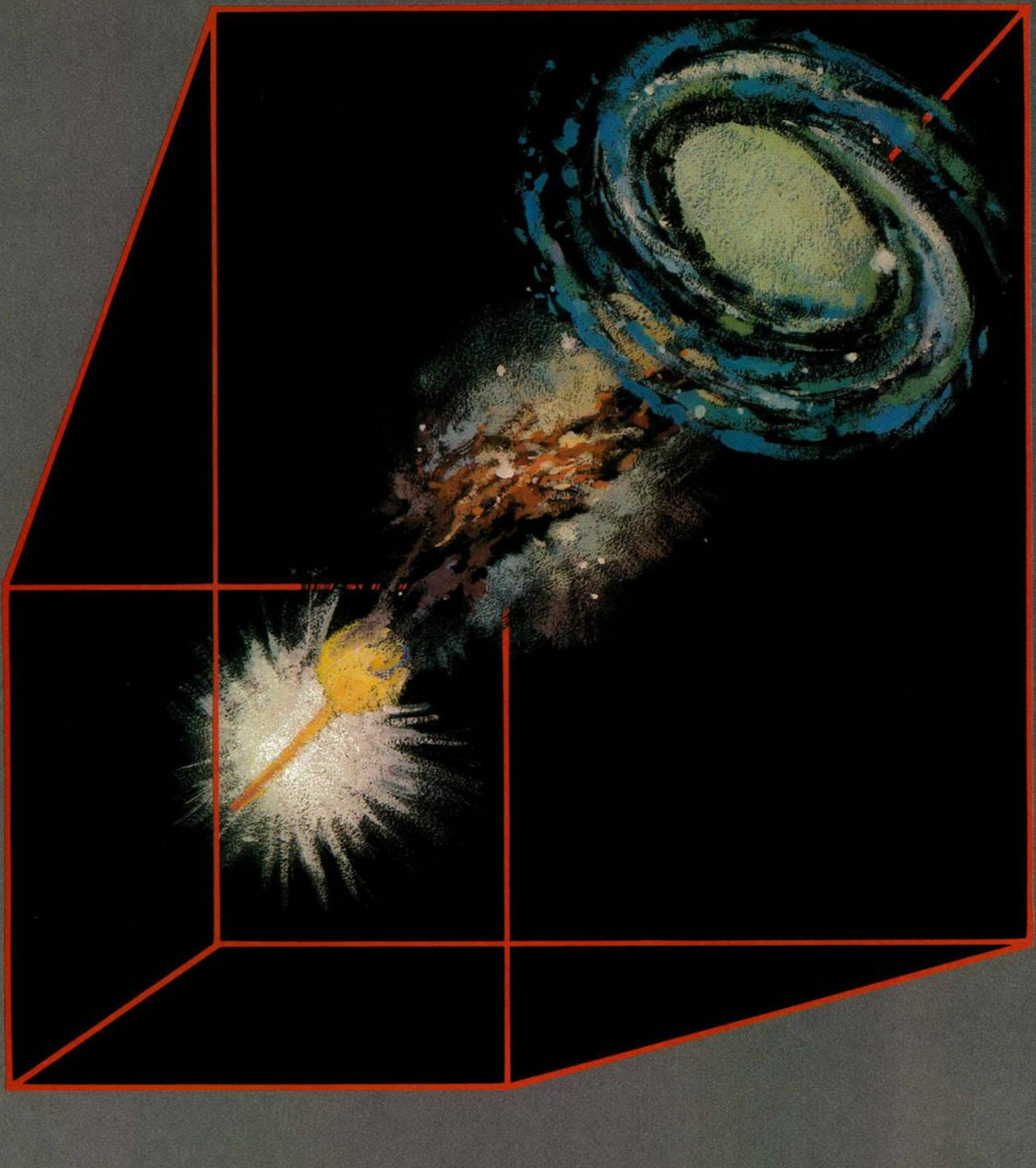
Another famous quasar, Markarian 205, has also been shown to have a nebulous outer region indicating that it, too, might be a galaxy. Even our nearest and brightest quasar, 3C 273, appears to have some nebulosity associated with it, and several astronomers are now convinced that many distant galaxies have quasars at their cores. But they can't say for sure if this applies to all galaxies.

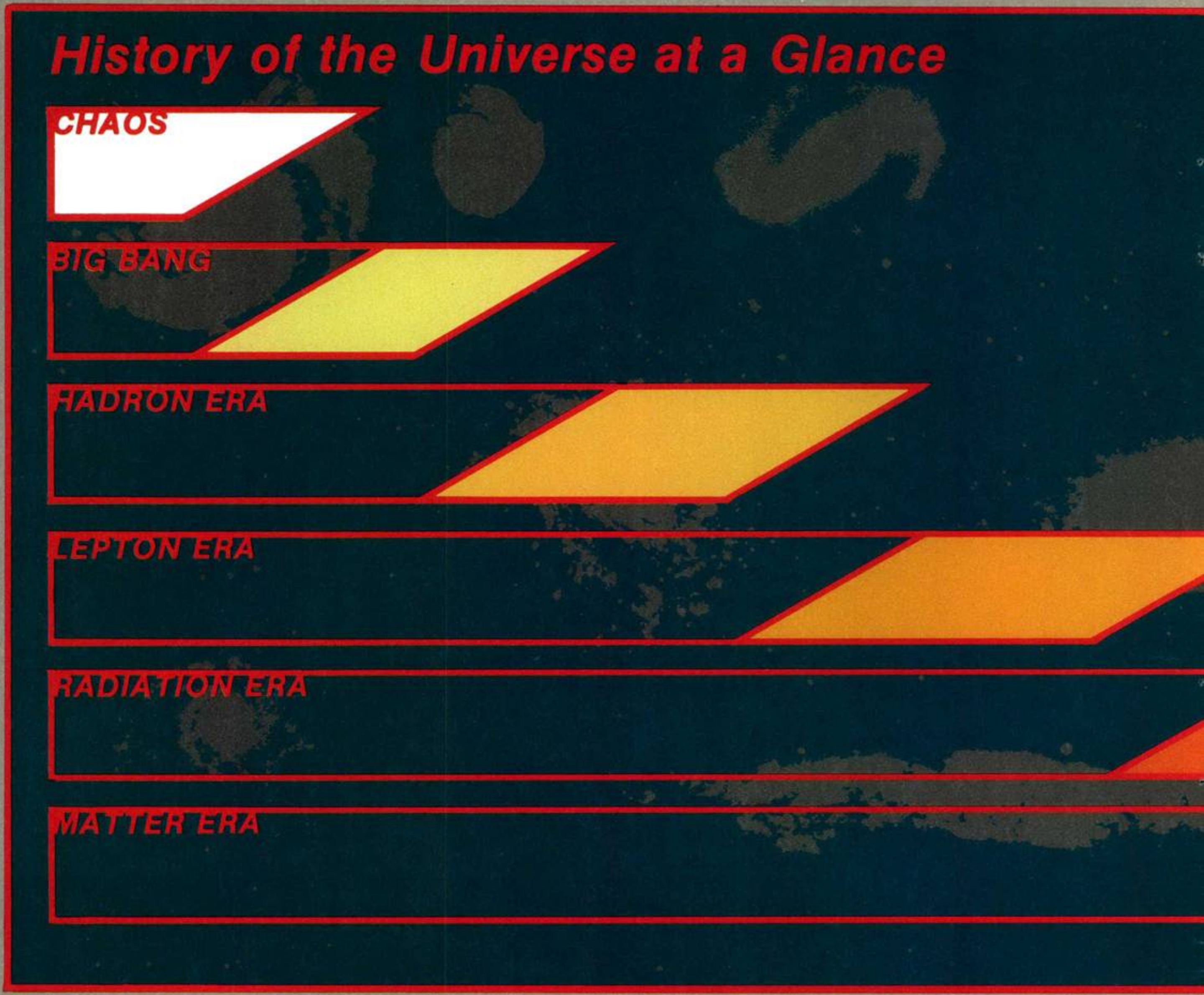
Quasars, then, could be associated with the early stages of galactic evolution and may even be the nuclei of all early galaxies, which means we are already seeing *primeval galaxies*, or the first galaxies. On the other hand these few quasars may be exceptions, and most galaxies may not be associated with quasars. One problem confronting astronomers is that they probably can't see galaxies near the edge of the universe because these galaxies are just too dim. This is the point of view taken by most astronomers. If quasars do exist at the core of distant galaxies, then those galaxies would be very luminous in their early stages of development. One way of determining whether quasars exist in distant galaxies is to estimate the amount of radiation produced over the galaxy's lifetime and then compare it to present observations of extragalactic background light. R. Stabell and Paul Wesson of the Institute of Theoretical Astrophysics at the University of Oslo, Norway, have done this and they conclude that galaxies were not much brighter when they were young than they are now. According to their study, spirals were probably dimmer, and ellipticals were only slightly brighter than they are now.

But if quasars are not primeval galaxies, we are still faced with the question: What do primeval galaxies look like? Astronomers have long been interested in how galaxies form and evolve into their present state, and considerable theoretical work has gone into this problem in the last few years. Observations of the early stages of galactic evolution would certainly be of great value in determining the validity of these theories.

The first search for primeval galaxies was made in 1967 by Bruce Partridge and James E. Peebles. Although they found none of these first galaxies, their efforts spurred

Astronomers searching for the first galaxies are uncovering information that could indicate an evolutionary sequence exists for the universe. Galaxies may evolve from radio galaxies which are thought to be linked to quasars.





other groups, and the search continues. We may finally be seeing the first direct evidence for this theory.

The appearance of primeval galaxies can be inferred by considering how galaxies evolve, and particularly how they evolve early in their life. Richard Larson of Yale University has used computer models on this problem and believes he can give a reasonable picture of this evolution. We know there are two major types of galaxies: spirals and ellipticals. In spiral galaxies star formation occurred long ago in the core regions. But spirals have long dangling arms that contain considerable gas and dust, as well as large numbers of young stars, so star formation still occurs in most of these galaxies. This means that star formation is a long drawn-out process in spirals, and therefore spirals were never particularly bright. Recent studies bear this out, indicating spirals are poor candidates for primeval galaxies, since we wouldn't be able to see them.

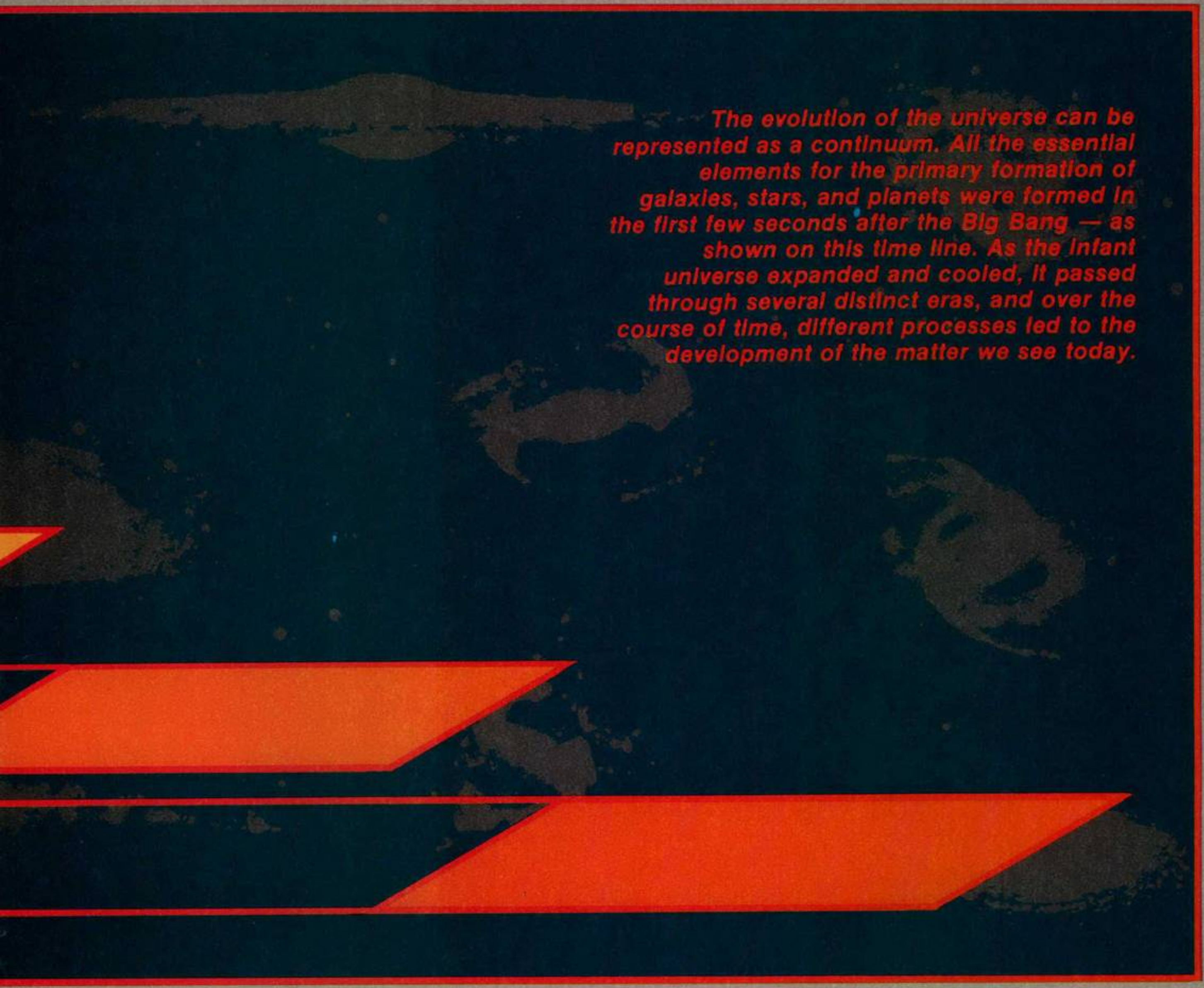
Ellipticals, on the other hand, do not have any gas and dust or young blue giants, and this hints that their star formation occurred over a short period of time. We can easily see why they don't have any young giant stars by considering what happens when a large gas cloud breaks up and a group of stars forms from the fragments. We know, first of all, that most of the stars that form will be small, and only a few will be blue giants. Furthermore, the few that become giants will evolve and explode in a short time, astronomically speaking, and the debris thrown out into space will eventually go into the creation of new stars. However, most of these new stars will be small red dwarfs. Today we see no blue giant stars in ellipticals. Those that once existed disappeared long ago, and now only small red stars are left.

What was the consequence of this rapid star formation? According to Larson, as the young giant ellipticals collapsed inward toward their centers of mass, the stars that orbited within them followed the collapse. However, the large gas clouds within the ellipticals fell rapidly toward the center, and as the gas accumulated, a rapid burst of star formation followed. Some of these stars were blue giants, and were joined by additional blue giants as more gas accumulated. Then suddenly some of them began to explode as supernovae and in a relatively short period the core of the elliptical began to shine exceedingly bright.

This implies that elliptical galaxies with bright blue cores are our best candidates for primeval galaxies. But if this is the case, we have a problem, because quasars also have bright blue cores, and there is some difficulty in distinguishing ellipticals from quasars at the great distances involved.

Clues from the Big Bang

In order to get a better perspective on these early galaxies, it's best to go back to the era immediately



The evolution of the universe can be represented as a continuum. All the essential elements for the primary formation of galaxies, stars, and planets were formed in the first few seconds after the Big Bang — as shown on this time line. As the infant universe expanded and cooled, it passed through several distinct eras, and over the course of time, different processes led to the development of the matter we see today.

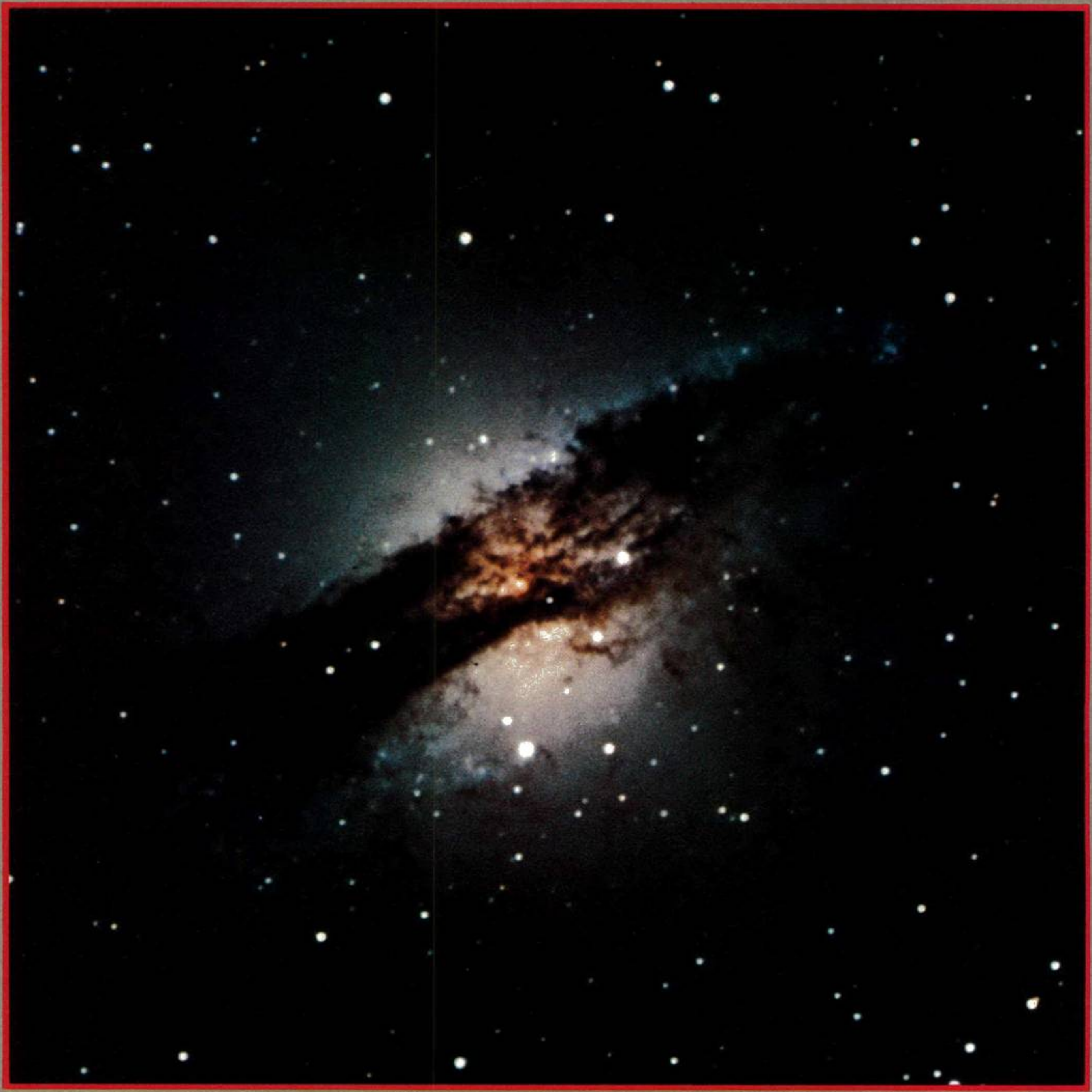
following the Big Bang and see how galaxies were formed. There are still many uncertainties and difficulties in studying this period, but astronomers have learned much in recent years. First of all, we know that galaxies are all approximately the same age — slightly less than the assumed age of the universe — so they could have evolved out of the material created in the Big Bang. Also, the mere fact that galaxies exist allows us to assume there was an inhomogeneity in the explosion, or at least that an inhomogeneity developed soon after the explosion took place. If the Big Bang were perfectly homogeneous and remained so indefinitely, we wouldn't have any galaxies today, because no collapse could have occurred.

There are two points of view on this early era. One group of cosmologists believes the explosion was entirely chaotic, but gradually decreased over a long period of time until it was smoothed into the generally homogeneous universe we see today. The second group believes that the universe initially had only a small amount of inhomogeneity which gradually grew and developed into galaxies. In short, we have the "chaotic" cosmologists and the "quiescent" cosmologists, and their points of view are at opposite ends of the spectrum.

One of the strong points of the chaotic cosmology theory is that it gets around the problems of the details of the initial turbulence. According to this theory, *any* initially chaotic distribution would result in the type of universe we see today. Despite the advantage of this theory there are some gaps in it. First, you need a soothing mechanism to gradually smooth out the initial chaos, but there is still no agreement as to what it might be. However, this mechanism would create energy, and we could see some of this energy in space today. The problem is that so far we haven't found any sign of it.

In the quiescent cosmology theory we are, unfortunately, forced to specify the initial fluctuations, and at the present time we can't. We do know they would be slight and would represent only a small deviation from the overall density. We might call them gravitational instabilities, but that's all we know about them.

The idea that gravitational instabilities might be important in forming various objects in the universe was advanced in the early 20th century by Sir James Jeans. Most of the present theories are based on his original idea, and of course go well beyond it. These instabilities would have been present very soon after the Big Bang — perhaps as early as a millionth of a second. We can only speculate about what caused them, but a number of educated guesses have been made. It is known, for example, that primordial mini black holes were generated at this time, and may have been responsible for causing these fluctuations. We also know that when black holes are very small, they explode in



NGC-5128 in Centaurus is both an optical and a radio source. According to current theories, radio galaxies are part of an evolutionary sequence separating quasars from normal galaxies. The Milky Way may have been a radio source at one time — or may become one in the future. Studying galaxies like NGC-5128 could help astronomers discover the processes surrounding galactic formation and the nature of the early universe. Photo courtesy Kitt Peak.

a short time and these explosions would certainly have caused some inhomogeneity. There has also been speculation over the years that black holes may be "seeds" that galaxies form around. In addition to this, astronomers think that quasars may reside at the cores of galaxies, and our "best" hypothesis about the nature of quasars indicates their massive energy could be produced by black holes. Therefore, it is possible that these theories have some basis in fact.

Some astronomers suggest that elementary particles are responsible for the fluctuations. According to recent theories all particles such as protons and neutrons, called *hadrons*, are composed of elementary units called quarks. We can think of a proton as three quarks confined in sort of a "bag." In our world today they are so firmly bonded that we have never seen them directly, but at the high temperatures associated with the very early universe, scientists believe they may not have been confined, and, in fact, the infant universe may have been a "soup" of free quarks. However, as cooling occurred, they were eventually forced together to form particles. The point that the changeover occurred is referred to as the *quark-hadron transition*, and many scientists believe that inhomogeneities occurred during this transition.

Astronomers have shown that two types of density fluctuations were possible in this early era. To see the significance of these two types, they turn to studying the early seconds after the explosion (see ASTRONOMY, "The First Second of Time," August 1979). In the first twenty seconds of its existence the universe passed through two eras known as the *Hadron* and the *Lepton Eras*. Particle production was particularly important during this time, and there were constant collisions with anti-particles resulting in total annihilation and consequently creating radiation. So in addition to large numbers of highly energetic particles, there was also a considerable amount of radiation. In short, the universe was a rapidly expanding sea of radiation, particles, and perhaps black holes.

How well did fluctuations fare in such a universe? Calculations show they were seriously affected. Two types of fluctuations were possible; *isothermal density* fluctuations and *adiabatic density* fluctuations. In isothermal fluctuations only the matter in the universe fluctuates; the sea of radiation around it remains uniform. In adiabatic fluctuations both matter and radiation fluctuate.

Although both types may have been present throughout the *Radiation Era* (the era that occurred after the Lepton Era), they changed very little during this time. Matter was continually bombarded on all sides by photons throughout the Radiation Era and could not collapse, because the radiation and matter were in equilibrium. Radiation was absorbed by the matter soon after it was created but was then re-emitted almost immediately. Because of this, any isothermal fluctuations that were created remained unchanged until the Radiation Era ended.

The adiabatic fluctuations fared no better throughout this era. Although they were not frozen in, they were severely damped. If a small adiabatic fluctuation suddenly occurred (i.e., the radiation and matter were suddenly compressed in a certain region) it created a wave that moved rapidly away from its source. (Imagine this wave as being like a sound wave, which dissipates soon after it's generated.) According to calculations, the waves would have been damped selectively. If the original wave had a sufficiently large amplitude, it may have survived.

Thus, as the Radiation Era ended, two types of fluctuations emerged. They did not grow or gravitationally collapse during this era, but at the end an event occurred leading to an important change. Radiation and matter were in equilibrium up to this point, but with the continuing expansion of the universe, temperatures were dropping rapidly. Finally when the temperature was down to 3000 K the electrons were captured by protons — creating hydrogen atoms. As a result the radiation decoupled from the matter and expanded freely into the universe. Once this occurred, gravitational instabilities could grow and eventually collapse into galaxies.

After decoupling, the surviving fluctuations, or protogalaxies as they are called, were free to grow. They continued to expand with the universe at first, but as their own gravity slowly increased their average density, they began to lag farther and farther behind. Finally they decoupled from the expanding universe and soon each was collapsing inward on itself.

One of the most encouraging results of these calculations is that the scale of surviving masses of the Radiation Era is in reasonable agreement with observations. The surviving masses of isothermal fluctuations correspond roughly to the mass of a dwarf galaxy or globular cluster. The surviving masses of the adiabatic fluctuations, on the other hand, correspond roughly to clusters of galaxies. Although they realize that the model is an oversimplification, this result has given astronomers considerable confidence.

But what are the problems, and why is this theory considered to be an oversimplification? First, the two types of fluctuations would have to interfere with one another. There would likely be a mixing of the two modes; newly formed structures could emerge or they could fragment. Furthermore we are not certain that both types of fluctuations existed. Perhaps only one of the two types formed, or perhaps neither of them formed.

Although most astronomers generally favor the gravitational instability theory of galaxy formation, other theories have been discussed from time to time — some of them taken quite seriously by certain astronomers. Some researchers have suggested that primordial magnetic fields may have played an important role in the formation of galaxies. These fields may have forced matter into gigantic lumps that gradually condensed into galaxies. *Lagging core* models have also attracted a considerable amount of attention in the last few years. In this model astronomers assume that some material from the Big Bang lagged behind the overall expansion of the universe. Galaxies may have formed around these lagging cores, or white holes as they are frequently called. As interesting as these rival models are, none of them has received the attention that the gravitational instability model has, and most astronomers are now convinced that it is correct.

Another look at protogalaxies shows us that soon after they decoupled from the universe they began to collapse inward as a result of gravity, and as they collapsed their density increased. However, the turbulence within them also increased and soon they began to fragment. Eventually even the fragments began to break up. Finally, the condensing lumps became opaque and trapped most of the radiation initially contained in the cloud. As they collapsed on themselves, the radiation pressure increased until it exerted a considerable outward force. When the outward force was large enough to balance the inward gravitational force, stars began to form and soon the protogalaxy was transformed into a galaxy.

With so much effort going into a theoretical understanding of how galaxies formed and what their appearance was during formation, it is easy to see why astronomers are particularly interested in seeing primeval galaxies. In 1984 they may have this chance, because the Space Telescope, a 94-inch reflector, will be put in orbit by the Space Shuttle. Although it is less than half the size of the Mount Palomar reflector, it will see much more, because it will not be hindered by our atmosphere. Astronomers expect to see objects at least 50 times as faint as the dimmest now visible. This scope will probe the universe even deeper and will aid the search for primeval galaxies.

Of course the Space Telescope is still a few years off, so it is reasonable to ask: What about now? Do we have any good candidates? Some potential primeval galaxies have been identified in the last few years, but just recently a particularly good discovery has aroused a lot of attention. A group of four galaxies was photographed by Hyron Spinrad and his team at Berkeley using the giant reflector at Lick Observatory. They are huge elliptical galaxies, each containing about a trillion stars — approximately 10 times as many as our Galaxy. Their light is blue — indicating that the stars are young — and according to Spinrad they are at a distance of about ten billion light-years, making them the most distant galaxies ever seen (they are two billion light-years farther away than those previously thought to be the most distant galaxies). They were, in fact, so dim that the image of one of them required 40 hours of exposure time to produce even a faint smudge on the photographic plate.

Are these objects primeval galaxies? We're not yet certain, but it is possible. Continuing research with larger telescopes on Earth and in space will push our visibility to the limit of the universe. Until we have a way of seeing these remotely distant objects, our theories will be incomplete. Even if we never develop telescopes powerful enough to see them directly, we are still seeing back into the dim reaches of time looking for that initial instant that led to the creation of the first galaxies.

Barry Parker is an associate professor of physics and astronomy at Idaho State University, where he teaches descriptive astronomy, astrophysics and cosmology. He recently finished a book on the early universe that will be published by Harcourt Brace.

The Bowl of Night

A HAND-CRAFTED THREE DIMENSIONAL PLANISPHERE FOR VIEWING THE NIGHT SKY

The BOWL OF NIGHT™ is a desk top planisphere, that solves the ancient problem of accurately representing the night sky. The vault of the heavens is more obvious than on any flat sky map. Skywatching is fun when you can understand how celestial objects move. By turning the opaque horizon hemisphere inside the blue bowl of stars, you can display the night sky for any hour of the night, any time of year. The BOWL OF NIGHT™ comes with an instruction pamphlet and is 14½" in diameter, made by SPHERICAL CONCEPTS, INC., the exclusive licensed manufacturer and distributor of the original BOWL OF NIGHT™. *Patent pending.

Another Hand-crafted Creation of **Spherical Concepts, Incorporated** 941 Parkview Drive King of Prussia, PA 19406 Telephone: 215:783-0272 Makers of **Spheres of Influence®**

To: **Spherical Concepts, Inc.**
941 Parkview Drive
King of Prussia, PA 19406

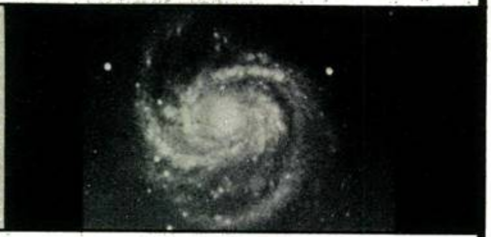
Bowl of Night™ — $65.00 ea.

Please send me ______ BOWL(s) OF NIGHT™ with instruction pamphlet(s). If I am not completely satisfied I may return my BOWL(s) OF NIGHT™ within thirty (30) days and receive a complete refund. Enclosed you will find my check for ________ plus three dollars ($3.00) for shipping and handling or bill by VISA/MASTERCHARGE card.

VISA/MASTERCHARGE
Card # ________________ exp. date ________
Name ________________________
Address ________________________
City ____________ State ________ Zip ________

NEW LUMICON DEEP-SKY FILTER™

1¼" + 2" Filters



M100 through a **Lumicon Deep-Sky Filter™**
Photo by Ron Potter on gas-hypered 2415 film

AT LAST! An LPR Filter for all deep-sky objects. Lumicon Deep-Sky Filter™ for 1.25" eyepieces **$49.95**
2" Filter for 2" eyepieces + photography (1.5" aperture)........ **$89.95**
48mm Filter for 2" eyepieces + telephoto lenses (1.75" aperture) **$79.95**

GIANT OFF-AXIS GUIDER* FOR C-11, C-14
— Has both radial and rotational adjustment for easy guide-star selection.
— Giant 80mm telecompressor lens for both viewing and photography at f/6.

LUMICON GIANT EASY-GUIDER™ $359.50
GIANT EASY-GUIDER™ w/o lens **$289.50**
LOW-PROFILE OFF-AXIS GUIDER*. Ideal for Newtonians or Cassegrains. Fits 2" focus mounts. Has 2 axis freedom for easy guide-star selection **$139.50**

GIANT EASY-GUIDER™ on C-14

FILM HYPERSENSITIZATION KITS*

LUMICON HYPER-KITS™ yield 3-30X true film speed gains. **All** films benefit.
MODEL 100 HYPER-KIT™ for 35mm film. Safe, refillable gas bottle for 100 rolls. Takes longer but is easy to use! **$199.50**
MODEL 300 HYPER-KIT™ sensitized 35mm film in hours. Yields highest possible film speeds. Best for 2415 users **$249.50**

(415) 447-9570 (CA res. add 6% tax). *Patent Pending

LUMICON

Dept. A-3, 2111 Research Dr., Livermore, CA 94550

HOLIDAY GIFTS available November 15 – December 31, 1981.

Gifts come boxed and wrapped in bright paper, ready for gift giving. Add $3.00 shipping and handling. Order Early!

(1) Beginner's Package $14.00 ($18.00 value)
  Atlas of the Heavens - Becvar
  6-inch celestial globe - Replogle
(2) Field Package $25.00 ($29.00 value)
  Carrying case for eyepieces.
  Sky Atlas 2000.00 - Tirion
(3) For Planetary Astronomers $35.00 ($40.00 value)
  Orbiting the Sun - Whipple
  The New Solar System - Beatty, O'Leary, Chaikin
(4) Beyond the Solar System $35.00 ($42.00 value)
  Milky Way - new 5th Edition - Bok/Bok - cloth
  Galaxies - Shapely/Hodge - cloth
  Galaxies & Quasars - Kaufmann - softbound
(5) Observer's Package $35.00 ($44.00 value)
  Sky Atlas 2000.00 - Tirion
  Field Edition to Stars & Planets - Menzel
  12-inch Celestial Globe - Replogle
(6) For Carl Sagan Fans $40.00 ($44.00 value)
  Cosmos - cloth
  Broca's Brain - cloth
  Dragon's of Eden - cloth
(7) Globe Lover's Package $40.00 ($47.00 value)
  12-inch moon globe - Replogle
  12-inch celestial globe - Replogle

PENTAX

7 x 20 MINI $119
9 x 20 MINI $139
wt. 7½ oz. ht. 4½"

with carrying case and lifetime warranty

Celestron

BINOCULARS
7x35 ... $185
7x50 ... $190
10x50 .. $200
11x80 .. $255
20x80 .. $285

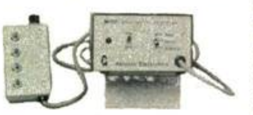
Tele Vue™

$55.00 EACH

7.4mm 10.4mm 17mm 26mm EFL
observer chosen focal length range

4-ELEMENT PLOSSL TYPE-razor sharp images, full color correction
WIDE 50 FIELD-larger than orthos, sharp to edge, ideal for RFT's
MULTICOATED-for maximum contrast and brilliance
PARFOCAL-for viewing convenience
THREADED BARRELS– for Nebula and other filters
ASTRO-PHOTOGRAPHY-ideal design for eyepiece projection
SUPERIOR CONSTRUCTION chromed brass 1¼" barrels, blackened lens edges

M110 Deluxe Telescope Drive Correctors/
SINGLE AND DUAL AXIS



Abraxas Electronics are the finest in telescope drive correctors. Our M110 series provides the necessary accuracy required for astrophotography. Preset astronomical rates, "Fine Adjust" control range, fast and slow pushbuttons.

IN STOCK
MODEL 2080

Meade

PENTAX

Dynamax®

Celestron

ARM CHAIR ASTRONOMY
THE MILKY WAY Bart and Priscilla Bok
5th Edition .... $ 7.95
BURNHAM'S CELESTIAL HANDBOOK
Robert Burnham — 3 vols. $26.85
GALAXIES AND QUASARS
William Kaufman, III. .... $ 8.50
NORTON'S STAR ATLAS
Arthur P. Norton $18.95
GALAXIES Harlow Shapley / Paul Hodge .. $ 8.95
SKY ATLAS 2000.0 Wil Tirion $14.95
SEND FOR COMPLETE BOOK LIST

VISA® MasterCard

STORE HOURS:
Mon., Tues., Thurs., 12 - 6 PM
Fri., 12 - 8 PM Sat., 9 - 4 PM
Demonstrations by appointment only.
Illinois residents add 6% sales tax.
Send $2.00 for our new 24 page catalogue.

COSMIC CONNECTIONS

1460 N. FARNSWORTH AVENUE
AURORA, IL. 60505 312/851-5353

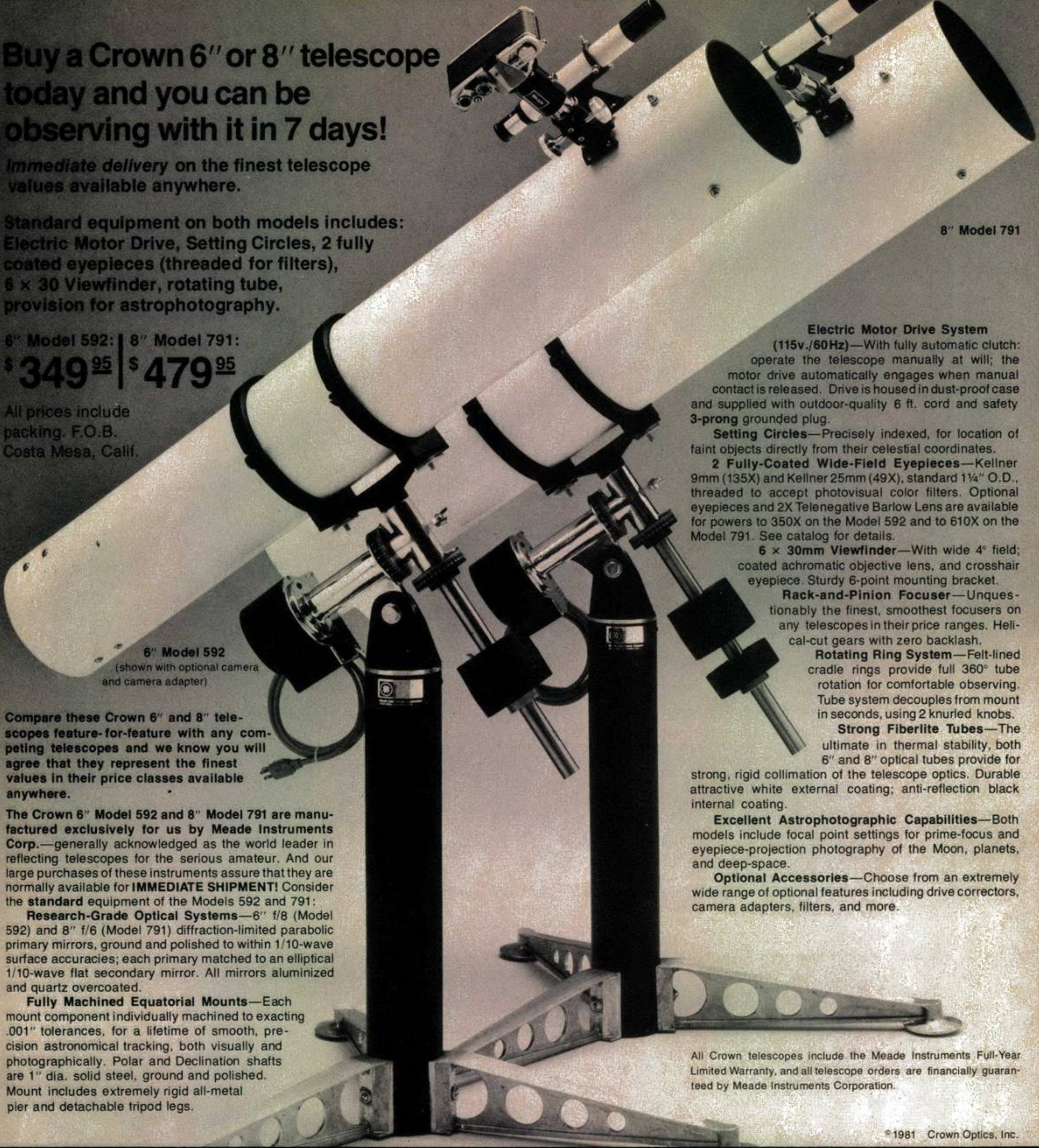
Buy a Crown 6″ or 8″ telescope today and you can be observing with it in 7 days!

Immediate delivery **on the finest telescope values available anywhere.**

Standard equipment on both models includes: Electric Motor Drive, Setting Circles, 2 fully coated eyepieces (threaded for filters), 6 × 30 Viewfinder, rotating tube, provision for astrophotography.

6″ Model 592:	8″ Model 791:
$^{\$}349^{\underline{95}}$	$^{\$}479^{\underline{95}}$

All prices include packing. F.O.B. Costa Mesa, Calif.



8″ Model 791

6″ Model 592
(shown with optional camera and camera adapter)

Compare these Crown 6″ and 8″ telescopes feature-for-feature with any competing telescopes and we know you will agree that they represent the finest values in their price classes available anywhere.

The Crown 6″ Model 592 and 8″ Model 791 are manufactured exclusively for us by Meade Instruments Corp.—generally acknowledged as the world leader in reflecting telescopes for the serious amateur. And our large purchases of these instruments assure that they are normally available for **IMMEDIATE SHIPMENT!** Consider the **standard** equipment of the Models 592 and 791:

Research-Grade Optical Systems—6″ f/8 (Model 592) and 8″ f/6 (Model 791) diffraction-limited parabolic primary mirrors, ground and polished to within 1/10-wave surface accuracies; each primary matched to an elliptical 1/10-wave flat secondary mirror. All mirrors aluminized and quartz overcoated.

Fully Machined Equatorial Mounts—Each mount component individually machined to exacting .001″ tolerances, for a lifetime of smooth, precision astronomical tracking, both visually and photographically. Polar and Declination shafts are 1″ dia. solid steel, ground and polished. Mount includes extremely rigid all-metal pier and detachable tripod legs.

Electric Motor Drive System (115v./60Hz)—With fully automatic clutch: operate the telescope manually at will; the motor drive automatically engages when manual contact is released. Drive is housed in dust-proof case and supplied with outdoor-quality 6 ft. cord and safety **3-prong** grounded plug.

Setting Circles—Precisely indexed, for location of faint objects directly from their celestial coordinates.

2 Fully-Coated Wide-Field Eyepieces—Kellner 9mm (135X) and Kellner 25mm (49X), standard 1¼″ O.D., threaded to accept photovisual color filters. Optional eyepieces and 2X Telenegative Barlow Lens are available for powers to 350X on the Model 592 and to 610X on the Model 791. See catalog for details.

6 × 30mm Viewfinder—With wide 4° field; coated achromatic objective lens, and crosshair eyepiece. Sturdy 6-point mounting bracket.

Rack-and-Pinion Focuser—Unquestionably the finest, smoothest focusers on any telescopes in their price ranges. Helical-cut gears with zero backlash.

Rotating Ring System—Felt-lined cradle rings provide full 360° tube rotation for comfortable observing. Tube system decouples from mount in seconds, using 2 knurled knobs.

Strong Fiberlite Tubes—The ultimate in thermal stability, both 6″ and 8″ optical tubes provide for strong, rigid collimation of the telescope optics. Durable attractive white external coating; anti-reflection black internal coating.

Excellent Astrophotographic Capabilities—Both models include focal point settings for prime-focus and eyepiece-projection photography of the Moon, planets, and deep-space.

Optional Accessories—Choose from an extremely wide range of optional features including drive correctors, camera adapters, filters, and more.

All Crown telescopes include the Meade Instruments Full-Year Limited Warranty, and all telescope orders are financially guaranteed by Meade Instruments Corporation.

© 1981 Crown Optics, Inc.

CROWNOPTICS Inc.

P.O. Box 8672, Newport Beach, Calif. 92660 Phone **714-966-1200**

ASTRO EYEPIECES (1¼″ O.D.) Thousands now in use throughout the world!

ORTHOSCOPIC—Excellent 4-element oculars, precisely corrected for chromatic and spherical aberrations. Fully coated, 45° field, threaded for filters. **Focal lengths: 4, 6, 9, 12.5, 25mm. Each $21.75 ppd.**

KELLNER—Super-priced 3-element eyepieces. High resolution, wide-field optics, fully coated. **Focal lengths: 9, 25, 40mm. Each $14.75 ppd.**

ORDERING INFORMATION

Mail and Phone Orders only! No dealer sales. We ship by United Parcel Service direct to your door in the U.S.A., and we guarantee the lowest prices in America on first-rate 6″ and 8″ telescopes.

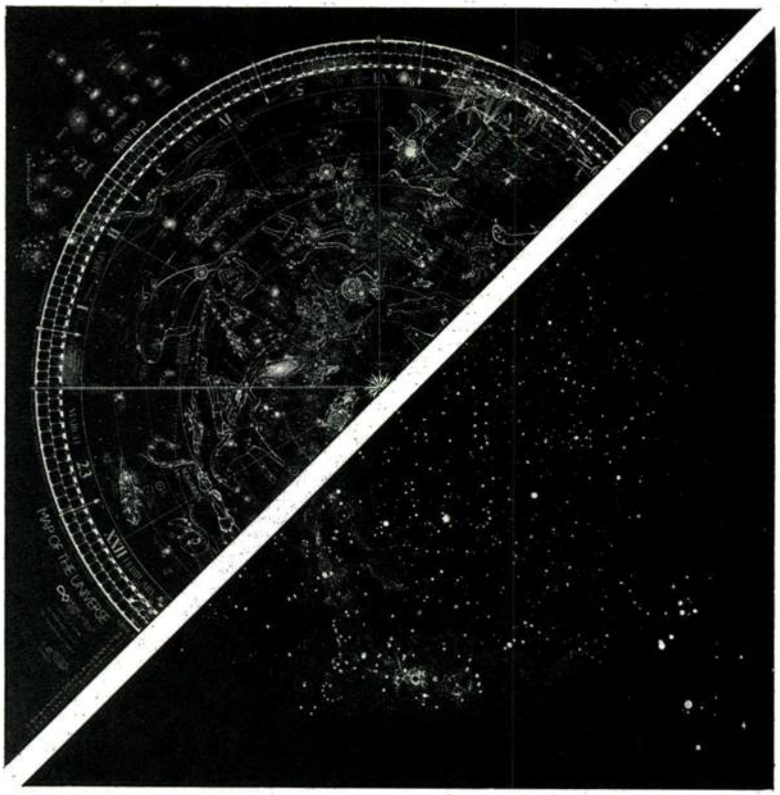
All shipments fully insured: Safe arrival guaranteed.

Payment: Personal or bank check, money order, or credit card (VISA or Master Card). Immediate shipment requires payment by money order, cashier's check, or credit card.

California Residents: Add 6% Sales Tax. **Canadian Shipments:** See catalog for details.

Catalog 81-C – $1.00 Crown telescopes, eyepieces, and accessories. Catalog forwarded by return First Class Mail.

Order Desk Hours—8:30-5:00 Mon.—Fri. Call us at **714-966-1200** for ordering, shipping, or technical information.



EXPLORE THE NIGHT SKY WITH THE
glow-in-the-dark
MAP OF THE UNIVERSE

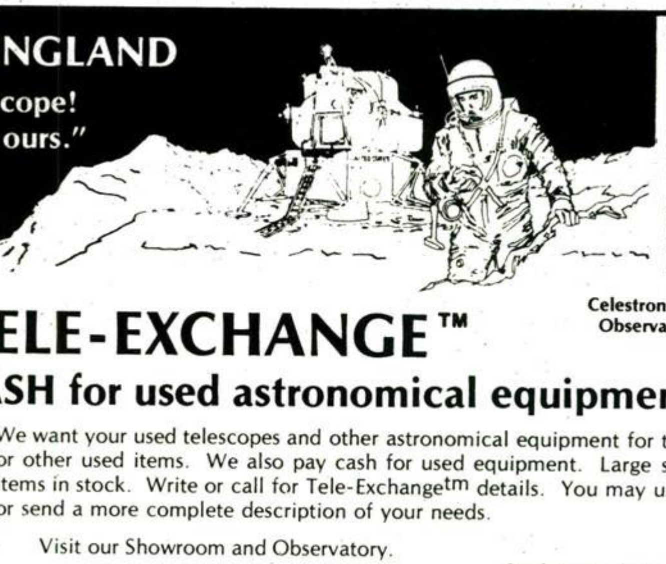
The **MAP OF THE UNIVERSE** helps you identify stars, constellations, supernovas, black holes and other celestial objects. This unique tool includes all the constellations visible from our Northern Hemisphere in full color on a 36″ x 36″ black background. And most of its stars are coated with a phosphorescent ink designed to glow in the dark.

Each Map is accompanied by a 16-page booklet giving instructions for viewing, as well as some of the legends about the constellations.

Learn the night sky indoors — so you can better search the heavens outdoors.

$10.95 includes postage and handling

To order, use the AstroMedia form bound into this magazine.



ASTRONOMY NEW ENGLAND

"We want your telescope!
. . . . and you'll want ours."

Call Us First for
New and Used Telescopes!

We are pleased to announce . . . TELE-EXCHANGE™

Celestron • Meade • Edmund
Observa-Dome • Tele Vue

Receive $ $ $ CASH for used astronomical equipment.

★★★CELESTRON TRADE-UP SPECIALS★★★
(free shipping)
- ★ C8, coated, Wedge, tripod + ($5,295.) = new C14, coated, wedge, tripod
- ★ C8, coated, wedge, tripod + ($2,795.) = new C11, coated, wedge, tripod
- ★ C5, coated + ($695.) = new C8, coated

We want your used telescopes and other astronomical equipment for trade toward new or other used items. We also pay cash for used equipment. Large selection of used items in stock. Write or call for Tele-Exchange™ details. You may use coupon below or send a more complete description of your needs.

Visit our Showroom and Observatory.

Astronomy New England, Inc.
215-AM Highland Street, Holliston, MA 01746
(617) 429-1172 — Call Anytime!

New York, New Jersey Representative:
(212) 423-9430

Send $2.00 for "Universe Catalog"; $5.00 for Celestron, Meade, Edmund and "Universe" catalog package.

Name ____________________ Phone (   ) ____________
Address ____________________
City ____________ State ____________ Zip ________

Tele-Exchange™ Coupon
Please fill out and send or write description on separate sheet.

master charge

VISA

I have this used equipment for sale/trade: ____________________

I want to obtain the following equipment: ____________________

Celestron® Spotting Scopes

• FOR BEGINNING ASTRONOMY • NATURE STUDIES • VIEW HOME • SPORTING EVENTS

C90 Spotting Scope

The C90 Spotting Scope

This instrument is the same unit as the Astro Telescope but does not include the fork mount, electric clock drive mechanism, slow-motion controls and setting circles. It is provided with a photographic tripod adaptor so that you can mount it on any standard photographic tripod or the *Celestron photo tripod.* It can be used for astronomy, terrestrial viewing and telephoto photography. The C90 Spotting Scope is all you need if you only occasionally wish to pursue astronomical observations. It will show as much as the Astro Telescope and you can add the fork mount and drive at a later date.

The base price includes the optical tube assembly, 5x24 finderscope, star diagonal, 18mm ocular, 2.5x Barlow lens, photo tripod adaptor, lens cap, carrying case and instruction manual.

As a daytime telescope, the C90 is remarkably powerful. With it you'll see details on bees buzzing in flowers 20 feet away and recognize faces of friends at ½ mile. At night, there are countless wonders in a dark sky visible through the C90. The Moon will display a multitude of craters, rugged mountains, rills, and smooth plains (the lunar seas or maria). Other planetary companions in the solar system are readily available for your close scrutiny. You'll see Jupiter's cloud belts and the great red spot. The four large moons of Jupiter, the Galilean satellites, are easily seen as they race around the giant planet in endless cycles governed by the laws of celestial mechanics. The rings of Saturn are easily visible, too. Under dark skies, away from the lights and pollution of large cities you'll be able to see countless galaxies, star clusters and sites where stars are being born or have recently died. Countless details of the cosmos are revealed for your inspection!

Fox squirrel at 50 feet Celestron C90 Photo

Bird at 15 ft. Celestron C90 Photo

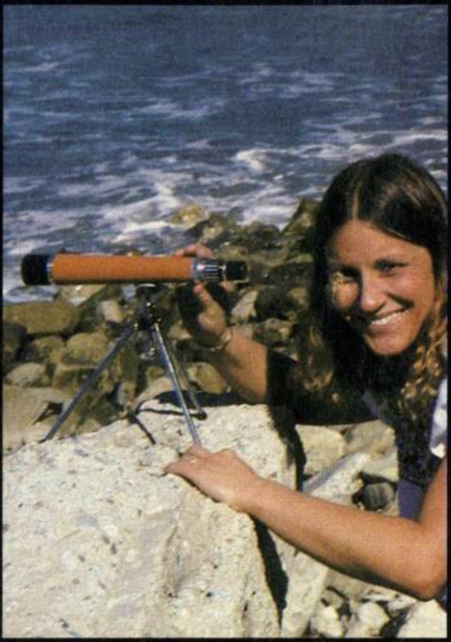
THE C90 SYSTEM

The C90 is a multi-purpose instrument that is offered in three versions. Each version can be used to view or photograph sky or earthbound objects.

The heart of the C90 series is the 90mm aperture, f/11, Maksutov-Cassegrain optical system which is identical in all three versions. As a result, the C90 is a telescope that's also a telephoto or a telephoto that's also a telescope. By adding the appropriate optional accessories, it is possible to use any C90 visually or photographically. For example, if your primary interest is to use a telescope for nature studies but you might occasionally wish to take terrestrial photographs, your needs would be well served by the C90 Spotting Scope. You would add an optional Porro Prism (for yielding upright or "normal" views), and with the addition of an inexpensive *T-adadptor* and *T-ring* you would be able to use your C90 Spotting Scope as a 1000mm telephoto lens! Note that as with any of our telescopes or telephoto lenses you can learn the details of its operation by requesting its operating manuals (included with purchase or available separately).

On examining the C90 you'll be amazed at the compactness, light weight and high quality of workmanship. Here is a 1000mm telephoto lens that gives the naturalist/astronomer/photographer tremendous versatility and all in an optical tube assembly that weighs less than 3½ pounds and is only 8 inches long.

C30 Zoom Spotting Scope



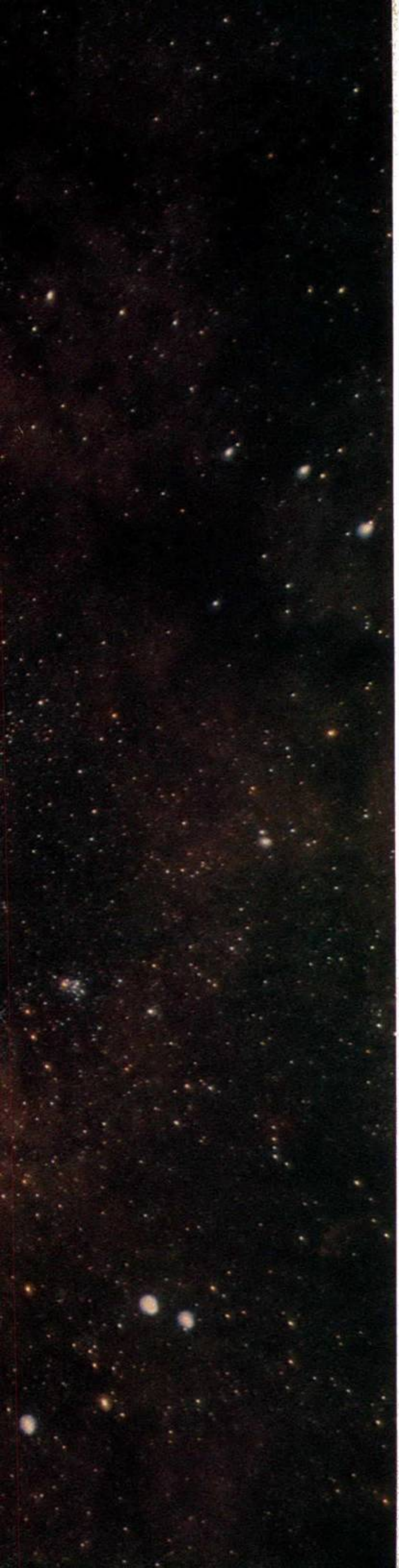
C30 Zoom Spotting Scope

The C30 Zoom Spotting Scope

The Celestron Zoom Spotting Scope is a complete self-contained telescope which needs no other accessories for its enjoyment. The Celestron Zoom Spotting Scope gives sharp views of objects in the sky or on the ground. Since you can focus from 20 feet to infinity, it also acts as a long distance microscope. The Celestron Zoom Spotting Scope is perfect for a young astronomer just beginning to study the sky; it will also give hours of satisfying viewing when it is turned toward terrestrial subjects on Earth. Bird watchers can use this highly compact and lightweight spotting scope for studies at long distances. This instrument is the only spotting scope offered by Celestron of other manufacture. The unit is imported to exacting Celestron specifications.

The Celestron Zoom Spotting Scope is intended only for visual studies of bright celestial objects and all terrestrial subjects; photo adapters are not available. The clear bright images make this telescope a joy to own and use; the Celestron Zoom Spotting Scope makes an excellent gift to neophyte astronomers or terrestrial observers. Note that astronomical viewing is much better when done away from the smoggy and light-polluted air of a city with any telescope. If you are seriously interested in astronomical observing, we encourage you to inspect our other large aperture astronomical telescopes.

SEE BACK COVER FOR CATALOG INFORMATION



close-up on cetus | through the eyepiece

Of the five naked-eye planets visible in November, four of them (Mercury, Mars, Jupiter, and Saturn) are in the morning sky. This leaves Venus as the solitary beacon in the evening sky. Of the outer planets, Uranus will pass through conjunction with the Sun, and Neptune will follow its example next month.

Mercury

As the diagram on page 112 shows, Mercury will shoot up above the east-southeastern horizon in the last days of October and the beginning of November. Greatest elongation (to the west of the Sun) comes on the 3rd, when the planet will be about 9½° high, 45 minutes before sunrise.

Early on the 6th (00:05 UT), Mercury will pass a little more than a degree north of Jupiter. At this time, they'll be below the horizon for viewers in North America, so look for them later that same morning in the hour before local sunrise. Use low to moderate powers on your telescope when viewing this pair. Jupiter will have an oblate disk 31" of arc across equatorially, and Mercury a gibbous one, 7" of arc in diameter.

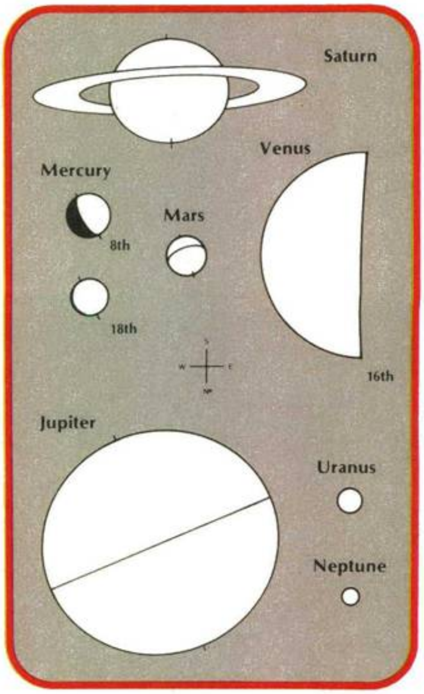
Low in the twilight sky, Jupiter may not be very impressive, but all four of its Galilean satellites will be visible. Ganymede (J3) will be on the western side, with Io (J1), Europa (J2), and Callisto (J4) on the eastern.

Three mornings later on the 9th, Mercury will lie very near a 6th magnitude star, SAO 139620. Whether you'll be able to see the star or not that morning will depend on how clear your eastern sky is about 10° above the horizon. Finding a 6th magnitude star that low in the twilight isn't very easy.

The summer Milky Way is all but gone from view, but photos like this one will keep its appearance in our minds as we single out the bright stars of winter. David Chalabie of Chapel Hill, North Carolina, wins this month's "Best Astrophoto" contest with his piggyback submission of the Sagittarius Starcloud.

Venus

Also reaching greatest elongation from the Sun this month — this time to the east — Venus will slow and halt its southward sweep along the western horizon. Climbing to a maximum altitude (45 minutes after sunset) of almost 20°, Venus is also gaining brightness. Between November 1 and December 16 — the time of greatest brilliancy — it will brighten from -3.9 to -4.4 magnitude.



From now until the planet disappears into the solar glare in early January will be a superb time to follow Venus' changing phases. Half-lit and at 23" of arc in diameter in early November, Venus will grow dramatically in size over the next two months while its illuminated portion shrinks. The point of greatest

brightness comes when a balance is struck between the diminishing fraction of the planet that is illuminated, its increasing closeness to Earth, and its increasing apparent size.

From 15:27 to 15:38 UT on the 17th, Venus will occult the 2.0 magnitude star Sigma (σ) Sagittarii. Eleven days later, at around 1:45 UT on the 28th, it will miss the 5th magnitude star 52 Sagittarii by some 9′ of arc.

The occultation will occur just before Venus rises for North America — though the two ought to be visible close together as soon as the sky darkens that evening.

The passing of 52 Sagittarii can be seen in a dark or moderately dark sky from about the Rockies westward. Since the event happens in the early hours of the 28th in UT, you should be looking on the evening of the 27th, local time. Both events will provide interesting sights in the eyepiece.

Mars

Moving steadily eastward along the ecliptic at about half a degree per day, Mars is now placed for easy observation by about 4:30 a.m. local time.

Telescopically, the planet has an orange-ochre disk about 5.5″ of arc in diameter. At present, Mars has its northern hemisphere tipped some 24½° toward us. The Sun, too, is over the martian northern hemisphere and moving northward toward the summer solstice which comes in early 1982.

On its eastward path, Mars will pass close by two stars in Leo: Chi (χ) at 22:03 UT on the 14th, and Sigma (σ) at 21:40 UT on the 22nd. Its distance from Chi will be about 26′ of arc north; from Sigma, 8′ of arc north. In both cases, the onset of daylight will force you to observe Mars and the star before the actual passage.

Asteroids

1 Ceres (magnitude 8.4) is in eastern Virgo. Its positions:

10th: 13h 17m 01s, +0° 14.7′
20th: 13h 33m 07s, -1° 18.2′

On the 20th at 9:17 UT, Ceres will pass 52′ of arc south of the 3rd magnitude star Zeta (ζ) Virginis. The timing works out such that you'll have to observe Ceres after it passes the star, but in the interval between the event and when the two rise high enough to be seen easily, Ceres won't have moved on very far to the east.

Since asteroids don't show visible disks, the close passage of one by a star is an easy way to locate these wandering minor planets without doing a lot of tedious star-plotting and cross-checking.

2 Pallas (8.8) lies near the borders of Leo, Virgo, and Crater. Its positions:

10th: 11h 33m 02s, -7° 32.1′
20th: 11h 50m 24s, -8° 08.7′

At mid-month, Pallas rises around 3:30 a.m. local time.

3 Juno and 4 Vesta both lie too close to the Sun to be seen this month. Vesta is in conjunction on the 15th; Juno on the 23rd.

Jupiter

Jupiter remains close to the Sun for the month of November, but not so close that it's impossible to see. Although it is low, you can still observe some details in the planet's cloud belts. Many telescope owners ignore Jupiter (and Saturn, for that matter) a month or two on either side of conjunction with the Sun.

It's true that by waiting for six to eight weeks after conjunction, you find the planet rising high above the thick layers of atmosphere that create blurry definition. Yet by waiting, you lose precious continuity. Not only do features come and go unnoticed, but visual sensitivity — important for seeing detail in the pastel colors of the jovian atmosphere — lessens. With a two or three month "holiday from Jupiter" your gas-giant observing skills can get surprisingly rusty.

Saturn

Saturn has now been overtaken by Jupiter and rises before it in the morning sky. More distant than Jupiter and with cloud belts far less active, Saturn demands close attention from anyone who wants to see much on the surface of its cloud deck. Start observing it now and you'll soon accustom your eye to the subtle features of its quiescent atmosphere.

Uranus

Uranus will be in conjunction with the Sun on the 22nd. It will be too close to the solar glare to be seen for several weeks to come.

Neptune

In conjunction with the Sun on December 16, Neptune will be quite difficult to find in the twilight of the evening sky. If you look very low in the southwest right after sunset on the evening of the 27th/28th (the same time as Venus' passage near 52 Sgr), you'll see the Moon, 1.4 days old and an extremely thin crescent, a little below and to the right of Neptune. Moving steadily eastward, the Moon will overtake the planet, but not before both have set.

Meteors

November features three meteor showers: the Taurid, the Andromedid, and the Leonid. With a radiant point roughly between and south of the Pleiades and Hyades, the Taurid shower (which consists of two sub-streams, one peaking on the mornings of November 3 to 5 and the other about 10 days later) produces some 10 to 15 meteors per hour. They are generally slow and bright, with a good number of fireballs — meteors brighter than -2 magnitude. The Moon's phase will be around First Quarter and will set early enough not to interfere with the shower.

November's second shower, the Andromedid, appears to come from a part of the sky just to the east of M-31, the Great Galaxy. With their meteoroid stream much perturbed by gravitational attraction of the planets (chiefly Jupiter), the Andromedids have lost much of their splendor during the last century: the display now has scarcely 5 to 10 meteors an hour. Worse yet, at peak activity on the morning of the 14th, the Moon — 3 days past Full — will interfere with obscuring brightness.

The Leonids, whose radiant lies in the "Sickle" (head) of Leo, also come off poorly this year. At their strongest on the morning of the 17th, the Moon will be a day before Last Quarter. This means it will hang brightly in the sky, washing out many of the fainter meteors.

Despite this year's probable poor display, the Leonids are well worth watching. The stream is produced by Comet Tempel-Tuttle, a periodic comet that returns about every 33 years. Sightings were numerous or at least above average in 1833, 1866, 1932, and 1933. At the comet's last return in 1966, the Leonid shower was the greatest display ever recorded — over 150,000 an hour! While we'll probably have to wait until 1999 to witness anything like that again, don't pass up a single Leonid display — no matter how moonlit the night may be.

close-up on cetus

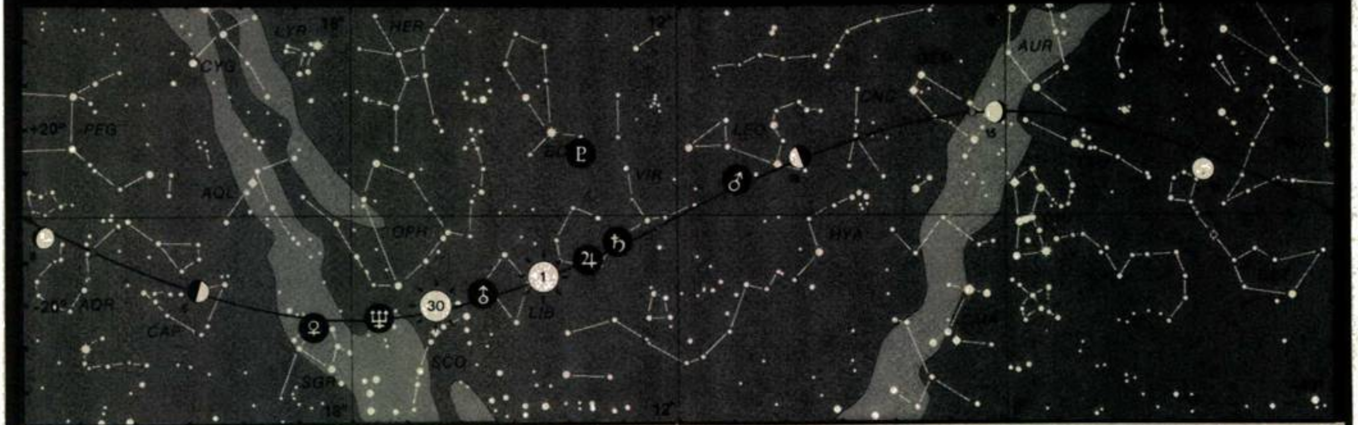
If you go out about 10 p.m. on a mid-November evening and look a short distance above the southern horizon, you'll see a broad expanse of featureless sky containing only a few stars.

You might, at a naked-eye glance, think it just another dim, dull, and barren void, and look elsewhere for sights to aim your telescope at. Perhaps you'd look to the southwest where the Square of Pegasus is slowly setting, or to the east where brilliant Orion is climbing into view.

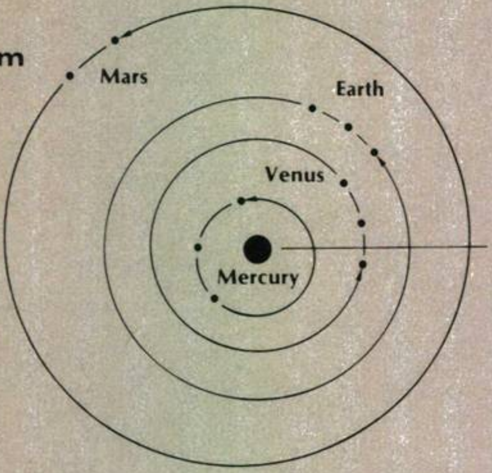
If you did, though, you'd be missing a lot. That dim patch of sky you just wrote off, though largely barren to the naked eye, has a good many celestial

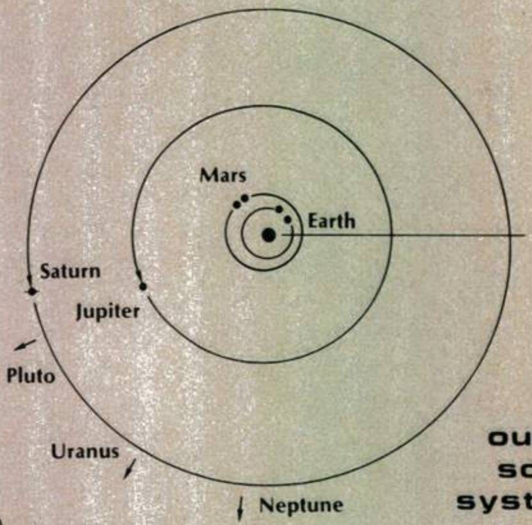
Guillermo Gonzalez used an 8-inch f/7 Newtonian and a 50mm eyepiece (afocal method) to record the partially eclipsed Moon. He used a Yashica FX-3 body and 200 ASA film at 1/30-second for this shot taken at 11:38 p.m. DST. This photo displays good color because the Moon had not fully entered the umbra.

planetary data november 1981



inner solar system





outer solar system

		Date	Mag.	Angular Size	% Illum.	Distance (AU) from: Earth	Sun	Longitude: Heliocentric	Ecliptic	R.A. (1981.9)	Dec
Sun		1	-26.8	32.3′	—	0.99	—	—	218°29.3′	14h 24.4m	-14°19.8′
		15	-26.8	32.4′	—	0.99	—	—	232°32.6′	15h 20.5m	-18°24.3′
		30	-26.8	32.5′	—	0.99	—	—	247°42.2′	16h 23.6m	-21°35.6′
Mercury	☿	1	-0.1	7.2″	48%	0.93	0.32	107°40.3′	199°57.2′	13h 17.3m	-5°57.6′
		15	-0.7	5.3″	88%	1.25	0.39	178°27.1′	217°45.8′	14h 25.3m	-12°40.1′
		30	-0.7	4.7″	99%	1.42	0.45	288°50.9′	241°20.9′	15h 58.7m	-20°32.8′
Venus	♀	10	-4.0	24.9″	50%	0.68	0.73	4°37.1′	274°06.0′	18h 20.5m	-26°49.8′
		30	-4.3	32.1″	39%	0.53	0.72	36°31.8′	292°41.6′	19h 42.5m	-24°24.4′
Mars	♂	15	+1.5	5.4″	92%	1.73	1.65	130°13.6′	163°40.2′	11h 04.2m	+7°51.0′
Jupiter	♃	15	-1.2	31.1″	100%	6.33	5.45	203°10.3′	207°06.8′	13h 43.9m	-9°34.8′
Saturn	♄	15	+1.0	18.8″	100%	10.42	9.63	194°15.5′	197°05.3′	13h 08.1m	-4°47.2′
Uranus	⛢	15	+6.0	3.5″	100%	19.83	18.85	240°18.3′	239°28.3′	15h 51.0m	-19°57.7′
Neptune	♆	15	+7.8	2.4″	100%	31.12	30.27	264°23.8′	263°00.0′	17h 31.6m	-22°00.8′
Pluto	♇	15	+14.0	—	100%	30.86	30.00	204°29.0′	204°55.3′	13h 58.2m	+5°40.4′

moon data

First Quarter	November 5 at 1:09
Full Moon	November 11 at 22:26
Last Quarter	November 18 at 14:54
New Moon	November 26 at 14:38
First Quarter	December 4 at 16:22
Full Moon	December 11 at 8:41

Perigee: November 12 at 11h . . . 357,106km
Apogee: November 26 at 21h . . 406,636km

universal time

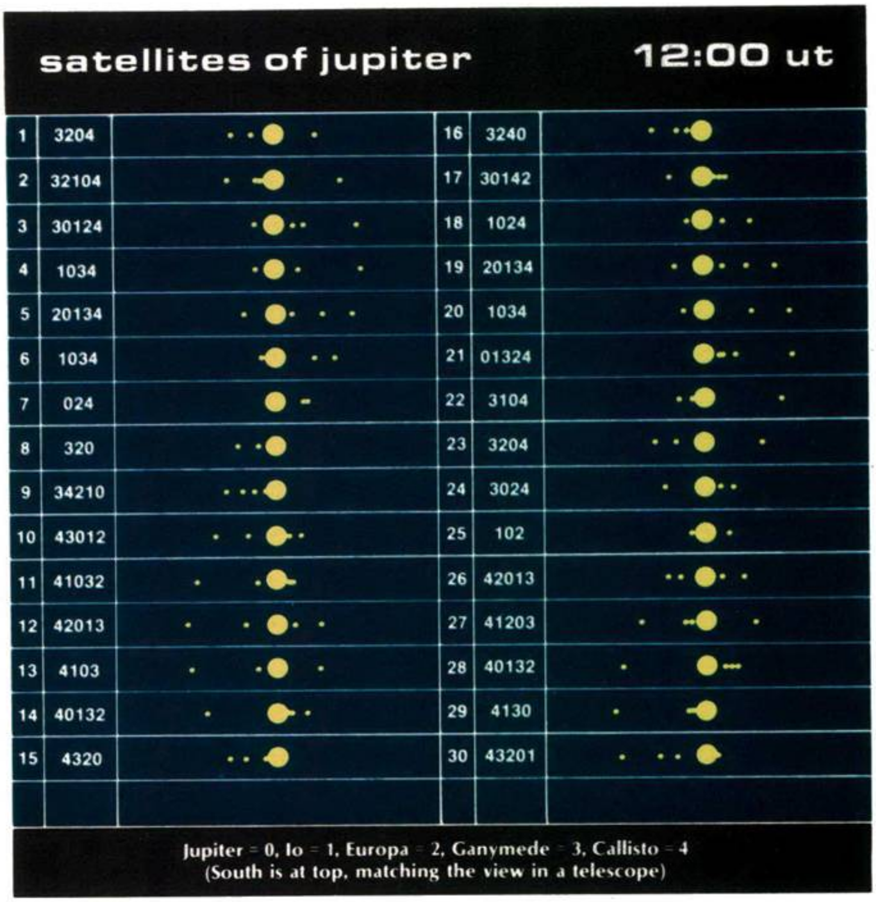
Astronomers the world over use an unambiguous system of time reckoning — Universal Time (UT) — based on a 24 hour clock. Times in Through the Eyepiece are UT unless otherwise noted. To convert UT into your local standard time, subtract the following number of hours for each time zone: EST, 5; CST, 6; MST, 7; PST, 8; Alaska and Hawaii, 10. For example, if an event is to happen at 03:00 hours UT on January 2, then EST for the event is 10 p.m., January 1. Likewise, 03:00 UT on March 5 becomes, in PST, 7 p.m., March 4.

This bright Perseid (about magnitude -4) burned up in the atmosphere above Kenwick, Washington. Dan and Nancy Ostergaard observed the shower and photographed this meteor at 3:40 a.m. PST. An 80mm f/2.8 planar lens and Tri-X were used for this 13-minute unguided exposure.

objects that deserve your telescope time. The region is Cetus the whale, and in it you'll find, among other things, a fine planetary nebula, a couple of galaxies, several double stars, and the first-known and most famous of all variables. But don't delay too long to set up for viewing — Cetus' appearance in the south is brief: by 1:30 or 2:00 a.m., it sinks too low for easy observing.

Let's start with something of a challenge. About 3.5° south of the celestial equator and a little more than half an hour of right ascension east of the vernal equinox, you'll find a 5th magnitude double star, **13 Ceti**.

Finding the star isn't too hard, but for most telescope users, splitting 13 into its two components won't be easy at all. With an orbital period of 6.9 years, the two stars in the system are never very widely separated. Greatest separation is only 0.4" of arc — difficult for even a 12-inch telescope under


satellites of jupiter
12:00 ut
1 3204
2 32104
3 30124
4 1034
5 20134
6 1034
7 024
8 320
9 34210
10 43012
11 41032
12 42013
13 4103
14 40132
15 4320
16 3240
17 30142
18 1024
19 20134
20 1034
21 01324
22 3104
23 3204
24 3024
25 102
26 42013
27 41203
28 40132
29 4130
30 43201
Jupiter = 0, Io = 1, Europa = 2, Ganymede = 3, Callisto = 4
(South is at top, matching the view in a telescope)

normal viewing conditions. To make it even tougher, right now the two are about half that distance apart. To split them, you'll need a large telescope and very steady seeing.

If you discover that 13 lies beyond your telescope's power, the next three objects should offer more. The first of them, a fine planetary nebula, **NGC-246**, makes an equilateral triangle with the two 5th magnitude stars Phi[1] (ϕ^1) and Phi[2] (ϕ^2) that lie to the northwest and northeast of it, respectively.

In medium to large telescopes, this 8th magnitude planetary has the appearance of a broken ring of smoke. Though photographs show it disk-like with dark patches reminiscent of the Owl Nebula, most smaller instruments will show it as a pale, oval shaped smudge of light. With moderate to large apertures you may pick up its 10th magnitude central star.

If you scan almost 9° due south from NGC-246, your view will glide over a 10th magnitude object much more distant than the planetary you just left: the spiral galaxy **NGC-247**. Though comparatively close as galaxies go (less than 10 million light-years away), NGC-247 is not part of the Local Group, but a member of the more distant Sculptor cluster of galaxies.

We are seeing it close to edge-on, which explains why its shape appears so elongated (almost north/south). Low powers work best because the galaxy covers a fairly large area but has a low surface brightness. It has a nucleus that is slightly brighter and, of the two extensions, the southern is brighter than the northern.

About 4.3° south of NGC-247 (and, incidentally, just over the border into Sculptor) lies a more splendid galaxy — **NGC-253**. Though many rank it as the most beautiful galaxy except for M-31 in Andromeda, NGC-253's "fan club" is certainly nowhere as numerous as it deserves.

The problem isn't brightness — NGC-253 has an integrated magnitude of 7.0 and can be located easily with binoculars in a dark sky. It's the galaxy's far southern declination that keeps it off the list of northern latitude favorites. Objects at -25° just don't stay visible for very long from these latitudes. If it were visible for as much of the year as M-31 is, NGC-253 would be far better known.

The best powers to use on it are the lowest you can manage. Having an oval shape some 22′ of arc by 6′, NGC-253 is thought to be a spiral galaxy that we see edge-on. Even with a smallish telescope, you'll have little trouble picking out the central thickening that marks the nucleus and the extended "arms" of its galactic disk.

Some textbooks show a side-view diagram of the Milky Way Galaxy to illustrate where the Sun is within it. If you've ever seen such a diagram, you're now looking at its real-life prototype. Pause and take a moment to marvel at this great stellar pinwheel, perhaps a twin of our own Milky Way.

From NGC-253, let's shift our attention eastward about an hour of right ascension and northward about 7°. There, in the whale's "underbelly," lies a strangely behaving variable, the prototype flare star — **UV Ceti**.

UV is actually a double star system, with the fainter member of the binary being the variable. Flare stars are extremely numerous throughout the Galaxy, but because they are also very dim intrinsically, none are seen beyond the Sun's immediate vicinity. We can see UV easily because it's only about nine light-years distant.

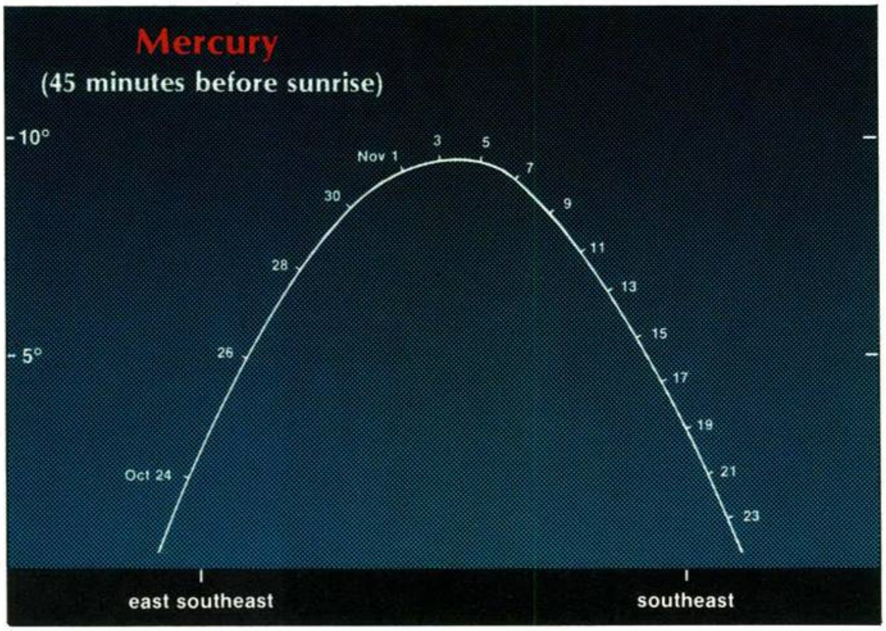
The orbit of the binary system (as mentioned in Burnham's *Celestial Handbook*) is highly uncertain. The secondary appears to be arcing through the closest part of its orbit and heading out toward greatest separation. But what that separation will be — and when UV will reach it — no one yet knows. At present, UV lies a fairly easy 6″ of arc to the northwest of its primary.

The variation of light in UV Ceti stars is simple: abruptly, they flare up, gaining a magnitude or two in a few minutes and then just as quickly fading again. On occasion, the flare can be dramatic — in 1952, UV Ceti rose from 12.9 magnitude to about 6.8 *in 20 seconds*. Since the variation is irregular, you never know when UV (or any other of its type) is going to "pop off" — so never pass up a chance to gaze at it for a while. Who knows? You may get lucky!

From UV, sweep 2.5° northeast and you'll arrive at a 3.5 magnitude star, **Tau (τ) Ceti**. Telescopically, Tau is a disappointment, but that's not why we're mentioning it. Tau is important because it is a nearby (11.8 light-years) solar-type star and thus a prime candidate for having a planetary system — perhaps like our own. Tau is a little cooler and dimmer than Sol — Stephen Dole (in his book *Habitable Planets for Man*) gave it only a 3.6% chance of having a planet suitable for human life — but no one has yet ruled it out.

In the spring of 1960, Project Ozma listened to the star with an 85′ radio telescope in the hope of detecting the radio noise of any civilization there.

M-8, the famous Lagoon Nebula, is rapidly descending in the west for most North American observers. This shot was made on June 29 in a cold camera with a 55-minute exposure on Ektachrome 400. Bill Iburg used an 11-inch Schmidt-Cassegrain in a dark California location to record this tremendous amount of detail.



Mercury

(45 minutes before sunrise)

The project lasted for several weeks and detected nothing, but as Dole himself mentions, a "reverse experiment" on our own solar system from there with identical equipment would have detected nothing. We may yet hear very interesting news from Tau Ceti one day.

Interestingly, any Tau-Cetian astronomers ought to be well aware of UV Ceti and its peculiarities. From Tau, UV lies only 2.8 light-years away (closer than Alpha Centauri is to us) and is of 10th magnitude. UV would appear to be about 8° away from the Sun — which would be a 2.6 magnitude star near Arcturus.

From the enigma of Tau, let's sweep 8.5° north and 9m of right ascension west to the distant spiral galaxy **NGC-615**. At 12.6 magnitude and with a diminutive size of some 3′ of arc by 1′, NGC-615 will not be greatly conspicuous except in telescopes of large aperture. On the other hand, many observers equipped even with smaller telescopes have noted how the nucleus stands out brightly in comparison to the elongated disk — which we are seeing from about 20° above the plane. What does your telescope show here?

Now scan 44m of right ascension east of NGC-615 and 4.3° north, where you'll find the famous star Omicron (ο) Ceti, usually known as **Mira**, "the wonderful." Mira was the first variable star to be discovered (in 1596), but it took several decades of observations before astronomers were certain that this star cycled regularly between magnitudes 3 and 10, approximately every 332 days.

The prototype of the so-called "long period variables," Mira has a great many imitators among the red giant stars of the sky. In fact, astronomers suspect that nearly every red giant is variable to some extent. In color, it has a strongly reddish-orange hue, which is easy to see around maximum light, but more difficult at minimum.

Mira has a companion, a bluish star that varies from 10th to 12th magnitude, and lies a scant 1″ of arc away from Mira at greatest separation. Lost in Mira's glare most of the time, careful observers with large aperture instruments and good seeing have watched it come into visibility as Mira fades toward minimum light. Don't confuse this companion with the unassociated 9th magnitude "field" star that lies about 2′ of arc to the east.

Having been at maximum in mid-August, by mid-November Mira should be well on its decline, below the naked-eye limit and sinking steadily. How long can you follow it in your telescope?

From Mira, let's turn our attention to another sprial galaxy — this time, one that made it into that first roster of deep-sky wonders, the "comets-that-aren't" list compiled by Charles Messier.

Our object, **M-77**, lies 3° north and 23m of right ascension east of Mira. You can also find it very easily by centering your scope on 4th magnitude Delta (δ) Ceti and looking half a degree east-southeast.

We are looking "down" on M-77 from about 90° out of its galactic plane, so the whole galaxy lies open to view. Even a small instrument will show a bright nucleus surrounded by the fuzzy patch of its disk — though you may have to look carefully and use averted vision. In a medium to large instrument, the disk begins to show details suggestive of arms.

M-77 has about the same mass and physical dimensions as the Milky Way but, spectroscopically, its bright nucleus shows emission lines that place it among the Seyfert galaxies — galaxies with active nuclei. It is also cataloged as the radio source 3C 71.

As you look out at this glow across 60 million light-years, think of the different paths taken by its evolution and our Galaxy's — or are they different? Was our Milky Way once a Seyfert? Or might it become one eons from now? The story astronomers are writing about how galaxies form and evolve is far from finished and who's to say how it will end up?

Returning to our own galactic precincts once more, our last two objects are double stars: **Alpha** (α) and **Gamma** (γ) **Ceti**. Target Gamma first because it lies 3.3° due north of M-77. It consists of a dissimilar pair of stars, one of magnitude 3.7, the other 6.4 — separated by a bit less than 3″ of arc. Since (as Burnham notes) the position angle between them has changed by only 3° in the last century, their orbital period is very long, possibly hundreds or thousands of years.

The brighter star has a spectral type of A2 (bluish-white), while the secondary star falls into the F3 class and is whitish-yellow. Webb described their colors as "yellowish" and "ashy," but other observers have opted for more colorful descriptions. Yet with this pair, colors are not easy to see — though they become more pronounced with larger apertures. What colors do you see in them?

Five degrees due east of Gamma lies our last object — the wide, bright pair **Alpha** (α) **Ceti**. With a separation of 16′ of arc (half the Moon's apparent diameter), the two stars of Alpha make a "binocular" double. But the doubling we see here is not that of a true binary system, where the two components orbit a common center of mass. Instead, Alpha is made from two stars, physically unconnected, that happen to lie close to each other in the sky.

The brighter of the two, a cool ruddy-orange giant, is at a distance of about 150 light-years. The dim star, much hotter and blue-white in color, is intrinsically brighter, but, since it lies over 500 light-years away, it appears several magnitudes fainter.

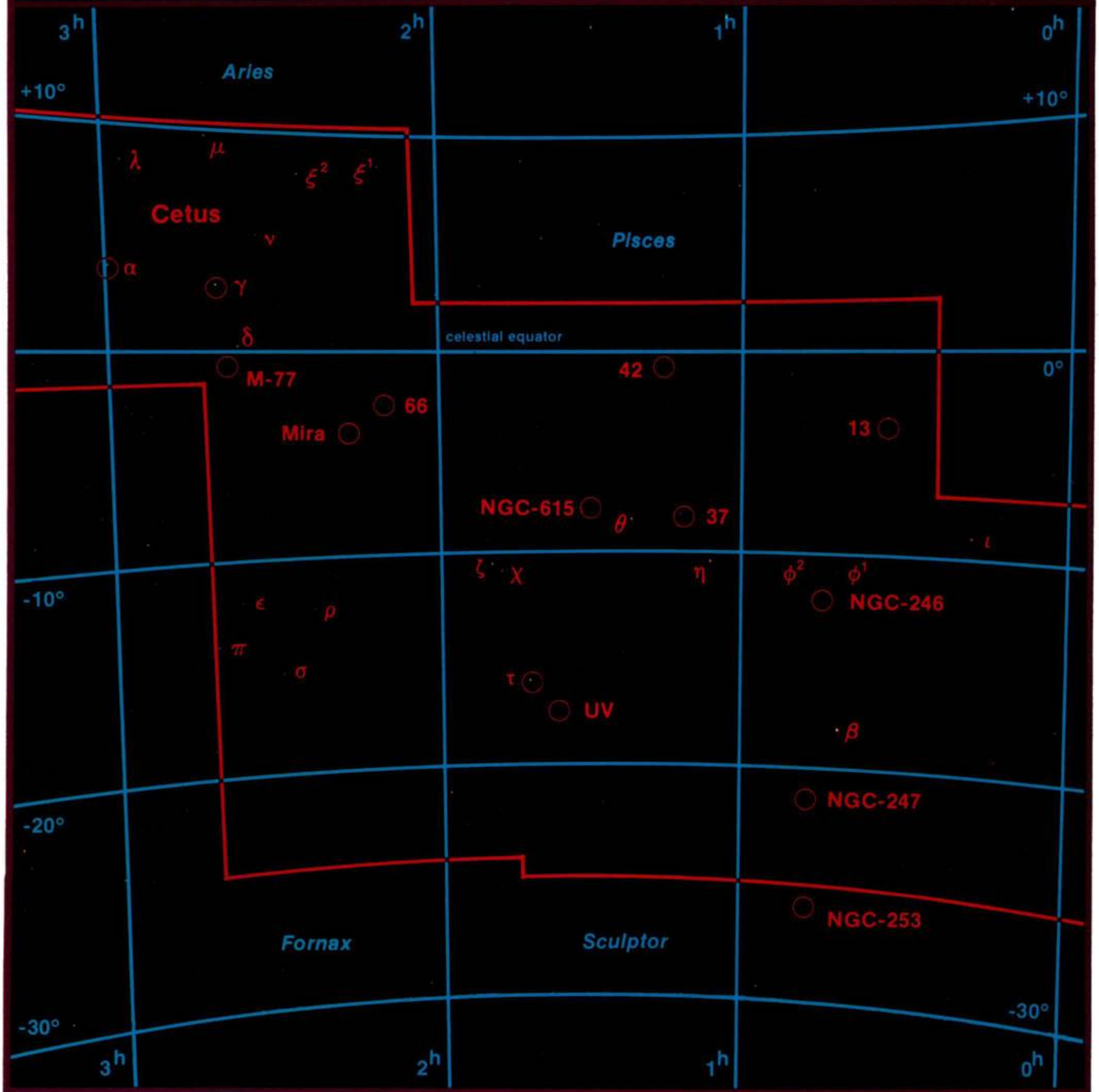
Because of their wide separation, you'll have to use your lowest power eyepiece if you want both stars in the same field of view. You may even find that binoculars or your finder scope give the best view.

Between them lie two 11th magnitude stars about 2′ of arc apart. Webb notes that the southernmost of the two is a probable binary pair with a separation of about 10″ of arc. How marvelous — a "double" framing a double!

photo by Brad Wallis & Robert Provin

cetus

map by Robert Burnham


3h
2h
1h
0h
+10°
+10°
Aries
λ
μ
ξ2
ξ1
Cetus
ν
Pisces
α
γ
δ
celestial equator
0°
M-77
42
66
Mira
13
NGC-615
θ
37
ι
ζ
χ
η
φ2
φ1
-10°
NGC-246
ε
ρ
π
σ
τ
UV
β
-20°
NGC-247
NGC-253
Fornax
Sculptor
-30°
-30°
3h
2h
1h
0h

Object	Type	Mag.	Size/Sep. Per.	R.A. (1950)	Dec.	R.A. (1981)	Dec.
13	★^{2}	5.5,6.5	0.2″	00h33m	-03°52′	00h34m	-03°42′
NGC-246	■	8.5	4′x3′	00h45m	-12°09′	00h46m	-11°59′
NGC-247	§S	10.7	18′x5′	00h45m	-21°01′	00h46m	-20°51′
NGC-253	§S	7.0	22′x6′	00h45m	-25°34′	00h47m	-25°23′
37	★^{2}	5.2,7.8	50″	01h12m	-08°11′	01h13m	-08°02′
42	★	6.4,7.3	1.6″	01h17m	-00°46′	01h19m	-00°37′
NGC-615	§S	12.6	3′x1′	01h33m	-07°35′	01h34m	-07°26′
UV	∩★	7-12.9	irreg.	01h36m	-18°13′	01h38m	-18°03′
Tau (τ)	★	3.6	—	01h42m	-16°12′	01h43m	-16°03′
66	★^{2}	5.7,7.7	16″	02h10m	-02°38′	02h12m	-02°29′
Omicron (ο)	♏★	3.2-10	332d	02h17m	-03°12′	02h18m	-03°04′
M-77	§S	8.9	6′x5′	02h40m	-00°14′	02h42m	-00°06′
Gamma (γ)	★^{2}	3.7,6.4	3″	02h41m	+03°02′	02h42m	+03°09′
Alpha (α)	★^{2}	2.8-5.6	15′	03h00m	+03°54′	03h01m	+04°01′

★	*Star*
★^{2}	*Double Star*
★^{3}	*Triple Star*
♏★	*Regular Variable*
∩★	*Irregular Variable*
♓★	*Eclipsing Variable*
○	*Open Cluster*
●	*Globular Cluster*
■	*Planetary Nebula*
□	*Bright Diffuse Nebula*
§0	*Elliptical Galaxy*
§S	*Spiral Galaxy*
§∫	*Barred Spiral Galaxy*
§#	*Peculiar/Irregular Galaxy*

ASTRONOMY'S SPACE 1982 CALENDAR

SPACE 1982
The Calendar of Space Art and Photographs from the Editors of ASTRONOMY Magazine

The Sun.

The Moon.

The Planets.

Beyond the Milky Way
to the Nebulae where
Stars are born.

ASTRONOMY's all new
Space 1982 Calendar
takes you to these
exotic places...

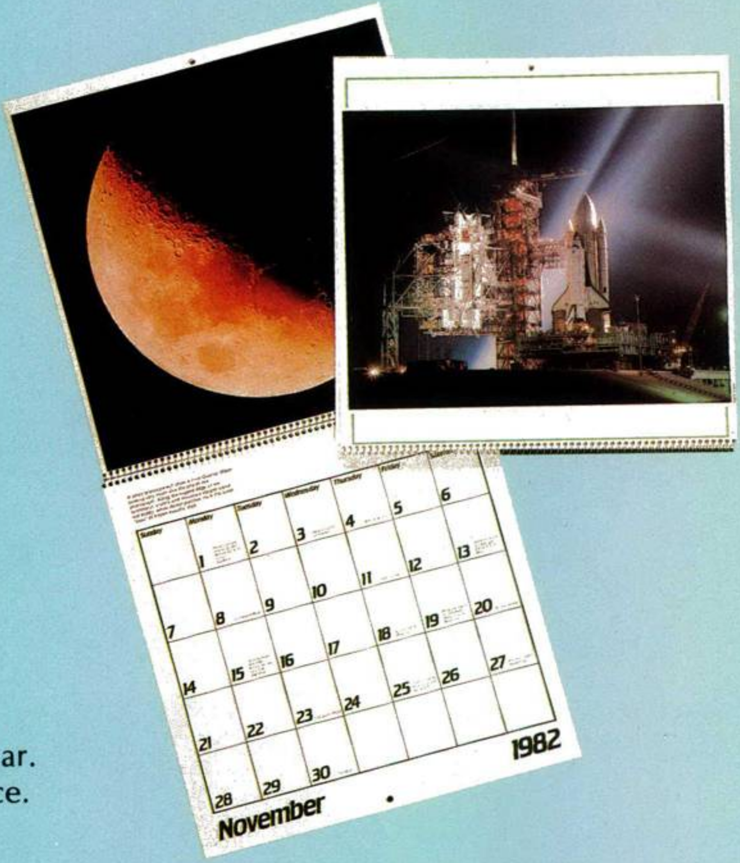
With colorful paintings
by today's finest space artists

With detailed NASA photos
made by Voyager on its
odyssey to Jupiter and Saturn

With a liftoff photo
of the Shuttle Columbia —
our first true spaceship

— 14 beautiful images
suitable for framing, plus
notable dates in astronomy
and space science.

ASTRONOMY's Space 82 Calendar.
It's a trip through Time and Space.

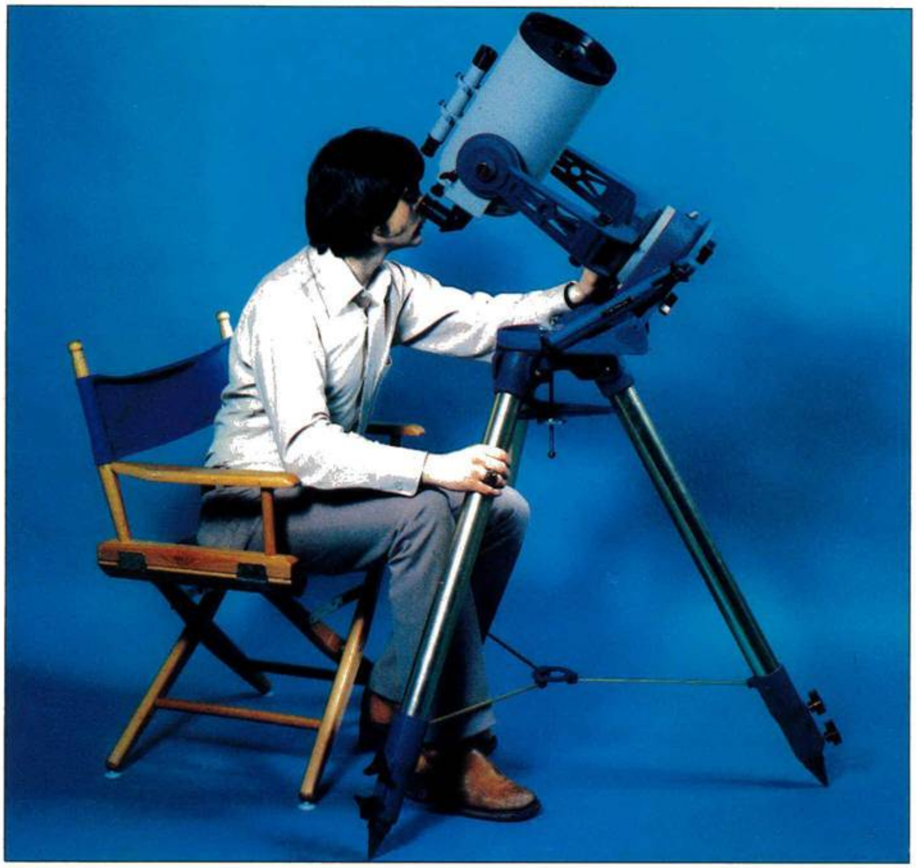

November
1982

$6.95 *Buy 3 Calendars for $20.85 Get a 4th FREE*

Postage and handling included

To order, use the form bound into this magazine.

We Took A Good Thing And Made It Better.



World's smallest six-inch telescope, the DYNAMAX 6, mounted on CSi Golden Pyramid Field Tripod.

When we first looked into the Schmidt-Cassegrain telescope, we saw it was a good thing.

We saw incredibly sharp images...compact portability...an unbelievable potential for versatility.

We saw a professional-quality telescope you don't have to be a professional to operate.

And we decided to build it.

We looked at our design from every conceivable angle, optically and mechanically.

We refused to compromise. We refused to cut corners. We made the telescope as good as we could make it.

Then we improved it.

And improved it again.

Today, the DYNAMAX Schmidt-Cassegrain represents the latest generation of large-aperture telescope performance.

And it's the best value in a modern telescope in the world today.

Not just because we introduced a Schmidt-Cassegrain.

But because we made it better.

DYNAMAX®

Another precision optical product from

CSi

Where Vision is a Way of Life

CRITERION SCIENTIFIC INSTRUMENTS

FREE COLOR CATALOG—When it comes to telescope performance, we wrote the book. And we'd like you to have a copy. Free. Write or call us today for your copy of the DYNAMAX color catalog and complete price list.

Dept. STB-106 • 620 Oakwood Avenue • West Hartford, CT 06110
Telephone (203) 247-1696

In New York:
Robert T. Little
Field Sales Manager
212-834-1888

In Florida:
William Douglass
305-667-9066

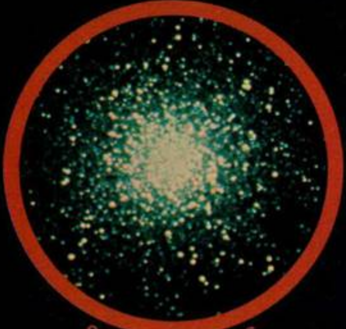
In Chicago:
Jim Michaelsen
312-851-5353

CELESTRON®

Telescopes… Telephoto Lenses… Binoculars

PLANETS

NEBULAE



STAR CLUSTERS

GALAXIES

Top to bottom shown above are the C14, C11, C8, C5, C90 Astro Telescopes

For a completely updated new 52-page catalog on all Celestron products, please send $3.00 to Celestron International, 2835 Columbia St. Box 3578-B, Torrance, CA. 90503 (213) 328-9560.